Menlo Park Notebook #25 [N-79-04-03]

This notebook covers the period April 1879-April 1880. Most of the entries are by Francis Upton and John W. Lawson. There are also entries by Edison, Charles Batchelor, and Francis Jehl. Most of the material relates to experiments on electric meters. Other material includes drawings of lamps and regulators; calculations and drawings of generators and motors; calculations for electric power distribution systems, and notes by Batchelor on things to be done. The label on the front cover is marked "Meter Experiments." The book contains 282 numbered pages.

Blank pages not filmed: 22-23, 44-45, 78-81, 126-127, 164-165.

Missing page numbers: 181-182, 274-277, 279-280, 283-284.

254

Deposit Co. 1 Weber
page 191, 251, 253

60

4

152
772
304
1064
1064
17344

4

Write Johnson about funnel of Bamboo

Pages 1 to 25. "Motor Meter Sketches."

. 25'

eter.

.)

4000

183

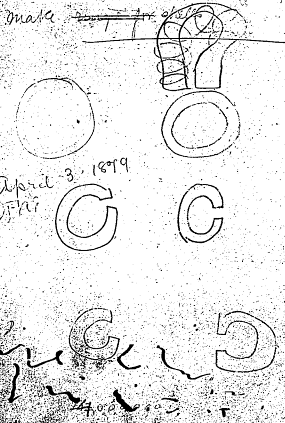
254

Deposit Co. / Weber
Page 191, 251, 253

BO/

Write Johnson about funnel
of Bamboo

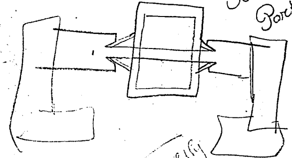
Write Fibre Co and see if they can
make ~~[illegible]~~



April 3, 1899
[illegible]

39.
40.

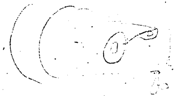
Portchester
Portchester



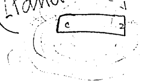
Fortnightly
Fortnightly
Fortnightly
Forwarded
Immediately

Fortnightly Fortnightly

9 fortnightly

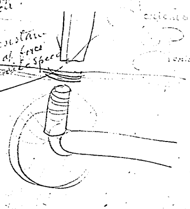


Portland



April 3rd 1879
TAE

Strongest field possible
Concentrate the core,
lowest magnetic Resistance
Cut all the lines of force
Highest practicable speed



April 3rd 1879

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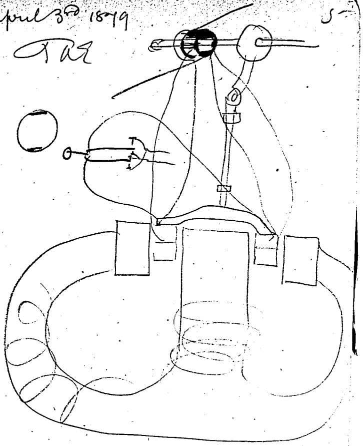

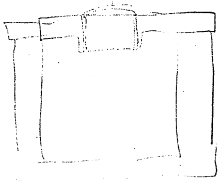

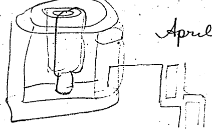

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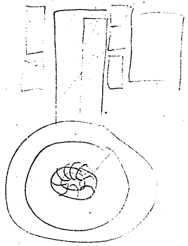

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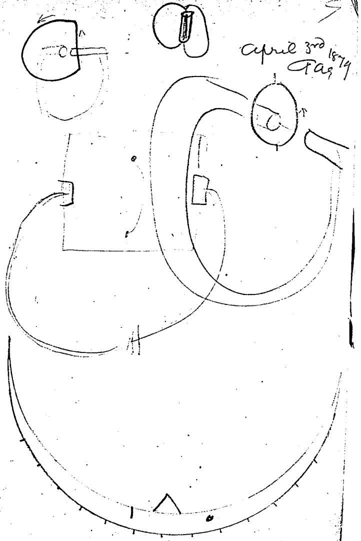

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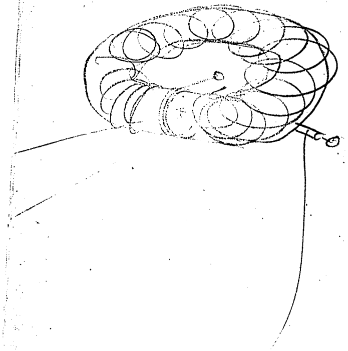

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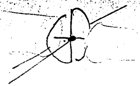

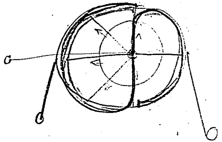

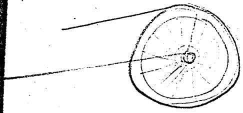

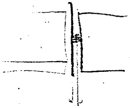

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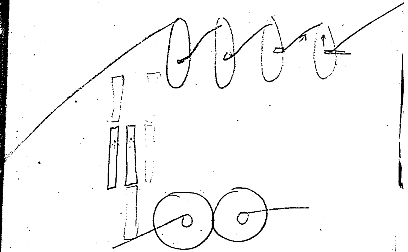

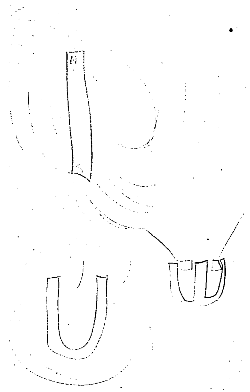

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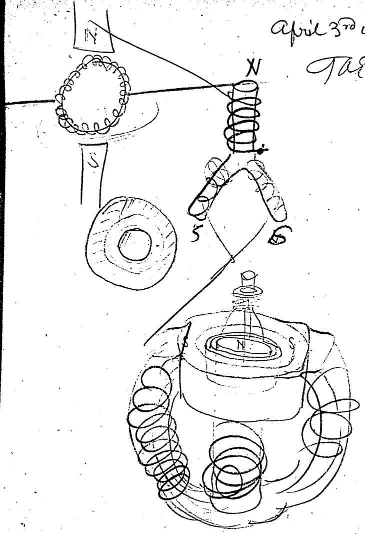

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17

April 3rd 1879
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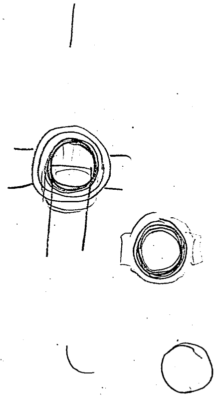
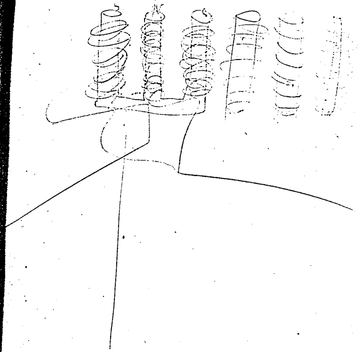


Zn goes to ~~Q~~ 7
from 8 to 6
from ~~9~~ 3 to 5
4 goes to Carbon

April 3rd 1879
T.A.E.



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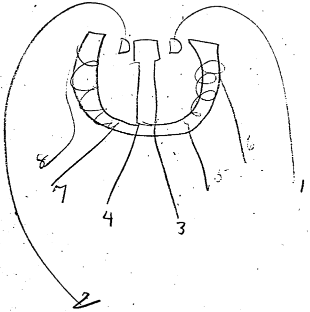
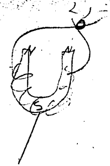
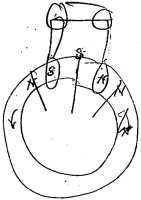
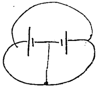
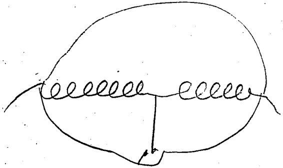


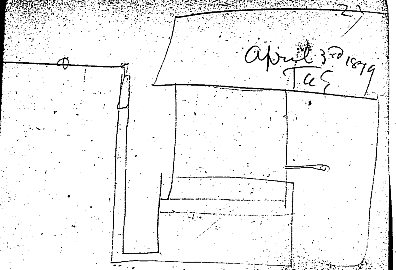
April 3rd 1899
JAG











339

$\frac{1}{2}$

54

3

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165 000
15 0000
13 2000

15

33,000) 12 000 (33
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9900
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Tortuous,

Pierpont Morgan

Peirrepont Morgan

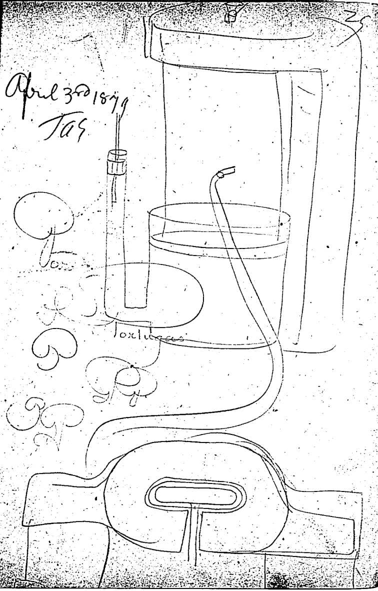
Drexel Morgan

Morgan

Morgan

Morgan

April 3rd 1879
TAE



April 4 1879

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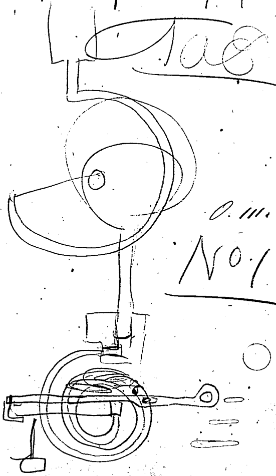

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No. 1

April 4 1879

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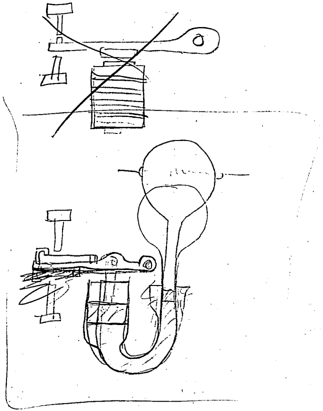
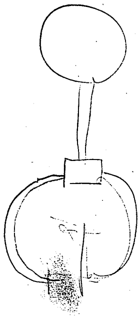


April 4
1879
B. No 113 TAE



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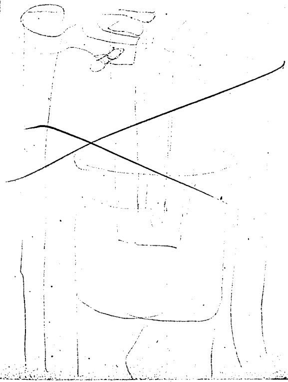

April 4 1879

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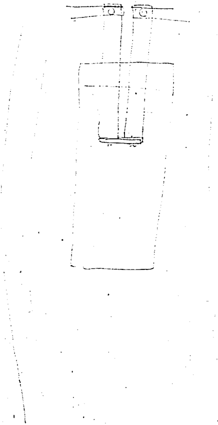

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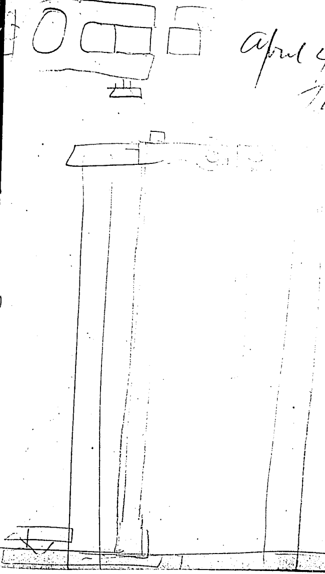

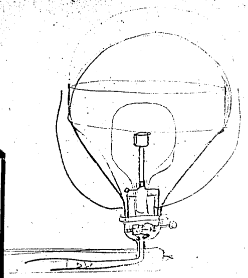

April 4 1879
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April 4 1879

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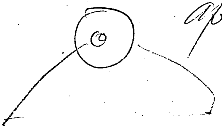

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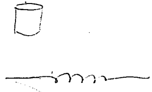

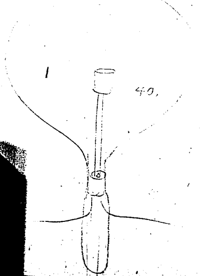

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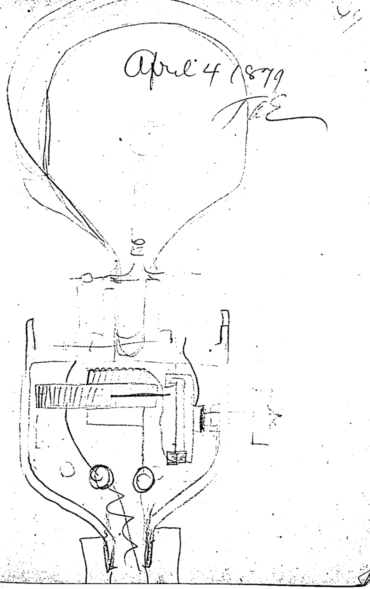

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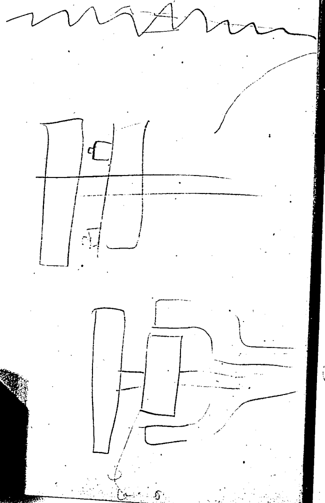

April 4 1879

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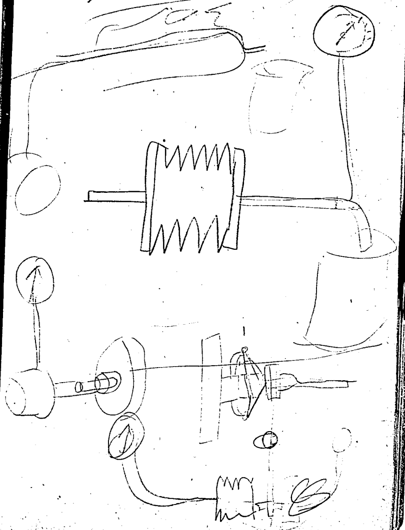
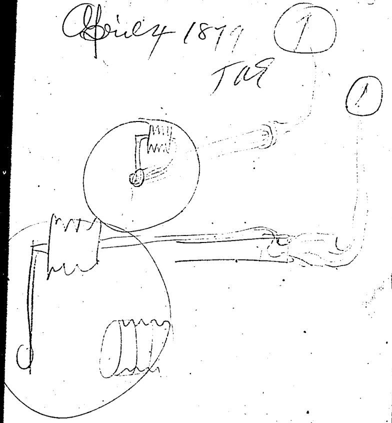


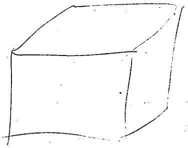
52

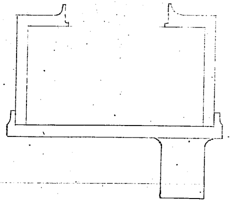
53

April 4 1879

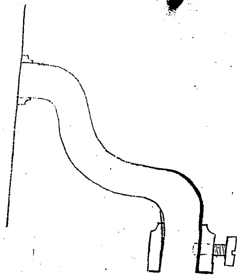
TAE



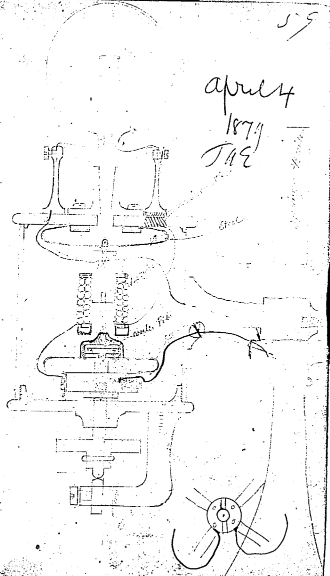




10 inch Disc
2 1/4 hole



April 4
1879
TAE



April 4 1879

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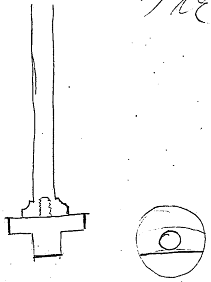

april 4
1879
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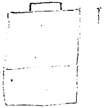
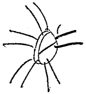


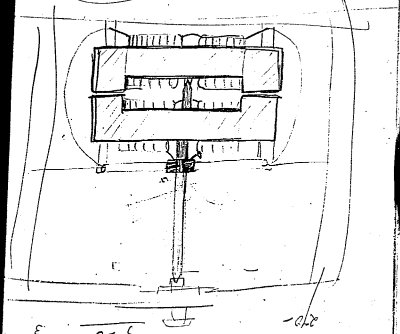


64

65

May 9 1879

Edison



May 9 1879
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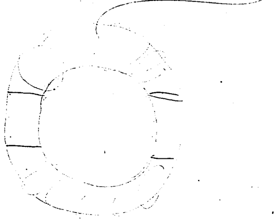
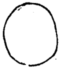
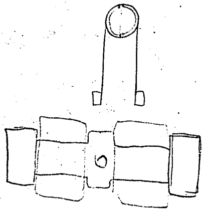
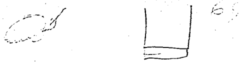
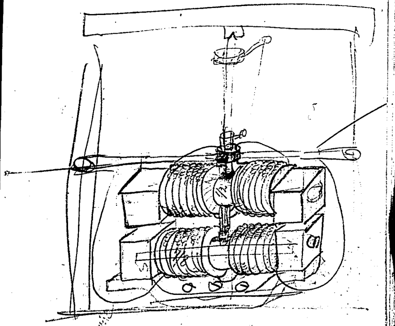


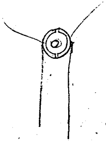






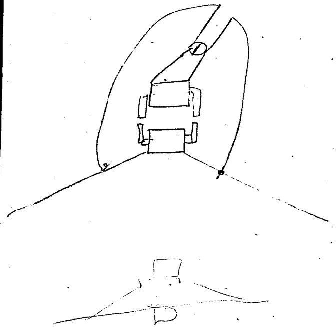


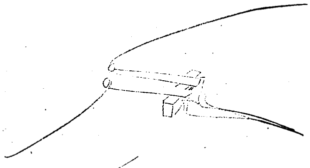
11 Layers of #26 wire

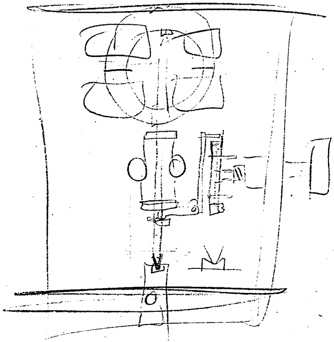


2 ohm Switch

4 turns







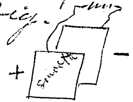
Two Daniel's cells
through 107 Ohms with
4 voltameters in circuit
each voltameter consisting
of 250 c.c. $Cu(NH_4)_2(SO_4)_2$
and 2 Cu plates each
exposing a surface of
8 sq. in. to the action
of the solution each
having one smooth side
and 1 rough side it
was found ~~that~~ the
smooth side of the
~~negative~~ positive electrode
was affected to such
a degree that a
thin section of the Cu
gradually ~~fell~~ peeled
off and was removed
mechanically by the
action of the solution

[ITEM FOUND IN BOOK]

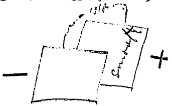
The action of $CuSO_4$ alone on Cu ~~on~~ extends through too short a space of time to allow of its being used with any practical result.

Add to a solution of cupric sulphate a small quantity of iron carb-

when it was placed as in the fig.



~~that~~ it was acted on in such a manner ~~that~~ ~~the~~ surface became covered with a film of finely divided Cu which by the mechanical action of the solution was removed rubber it was placed as in the fig.



[ITEM FOUND IN BOOK]

in solution 73 hours

Loss for	7	35
"	8	26
"	9	18
"	10	30
	11	19
	12	16
	13	24
	14	18
	15	11.5

No 9. 26.563/8

22.426 1/3

$\frac{7}{8} - \frac{1}{3}$ $\frac{21}{24}$ $\frac{8}{24}$ $\frac{13}{24}$

4.137 $\frac{13}{24}$

10·3449

250 cc $CuSO_4$
2 cc H_2SO_4
sp gr = 1·21
at 45°?

35, 26, 18
35, 25, 17 } 7 – 9

30, 19, 16
30, 20, 13 } 10 – 12

24, 18, 11·5
24, 16, 10·7 } 13 – 15

29

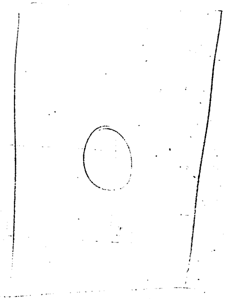
9·8182

13 – 6 Run

250 cc $CuSO_4$
2 cc H_2SO_4

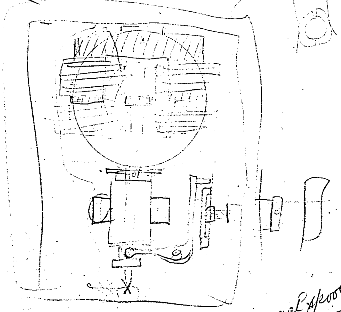
	S	L		
7	9	35	9	35
10	6	30	4·5	23·3
11	3	19	2·25	15·55
			1·3	16

28



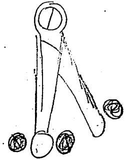
Regulators

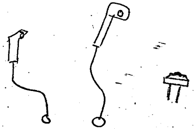
May 11th 1879

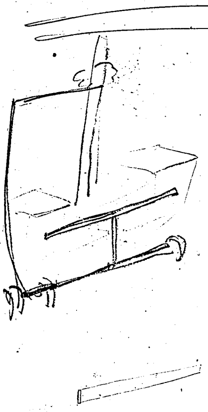


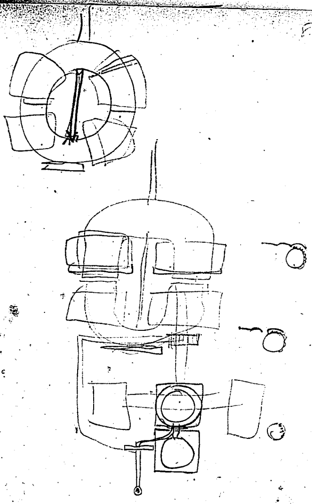
'04 in each spool

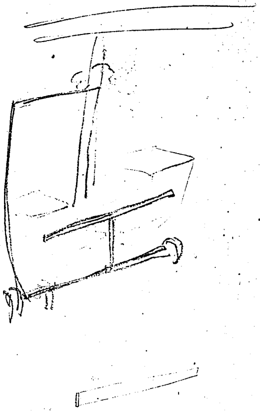
Batch make drawing

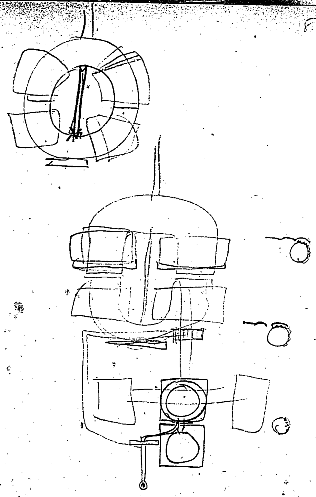


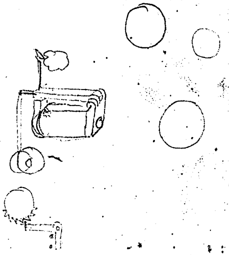






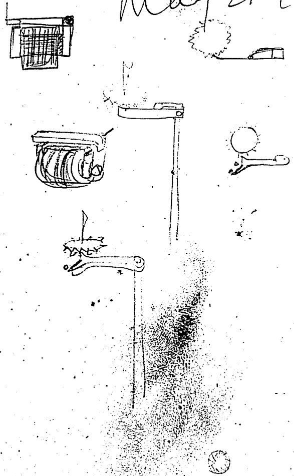


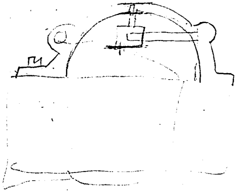


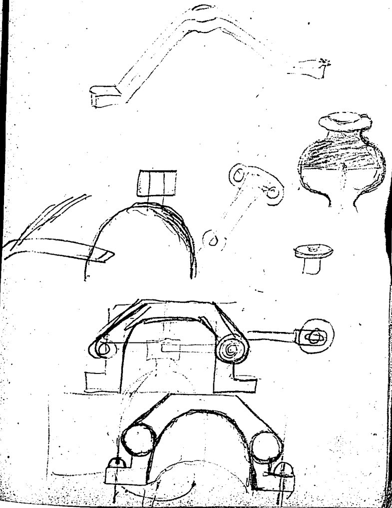


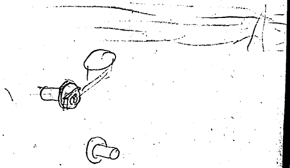
May 21 1879
Tai

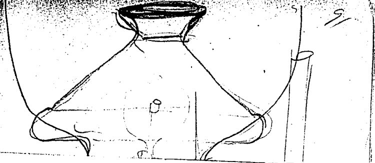
May 21 1879
Tai











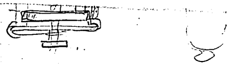
Edison Laboratory Note Book No. 25.

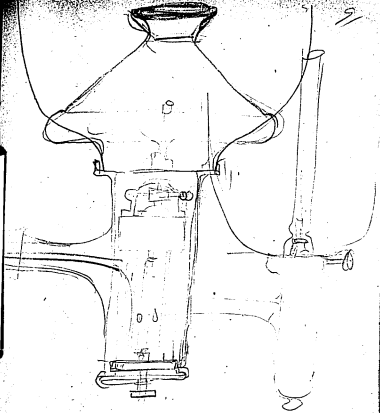
Pages 91 to 93.

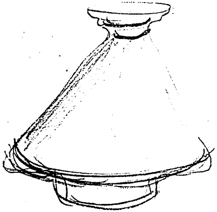
Incandescent Electric Light.

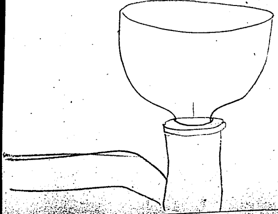
See Edison Patents:

214,636
214,637
218,866
227,227
227,228







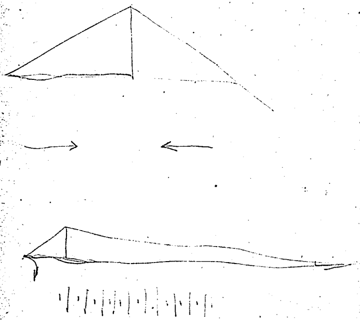


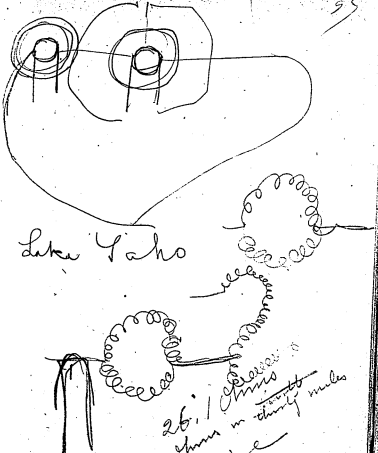
1.5125

1.62
3.14
648
162
486

.18) 5.0868 (.283
3.6
148
144
46

.283
25





Lake Taho

26.1 Ohms

26.1 ohms in thirty miles

1/4 inch wire

181

of

98

189 20
200

189
158

$7.509 for conductor

26.1 Ohms

10 machines ~~1000~~ volts

2000

10000

$1000 for a ~~HP~~ machine

say five H. P

200 a H. P.

99

$20 a year a H. P. for machine

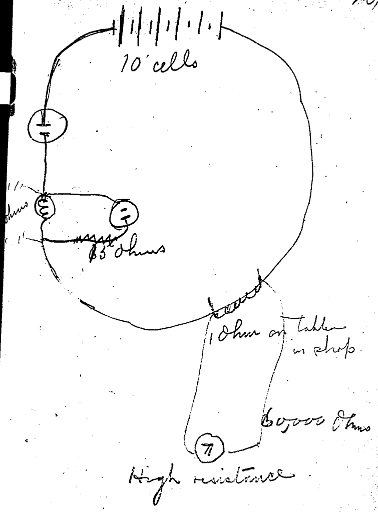
365)20 $\frac{20}{36.5} = \frac{100}{18.7}$

~~2 cts a day for interest a H.P.~~

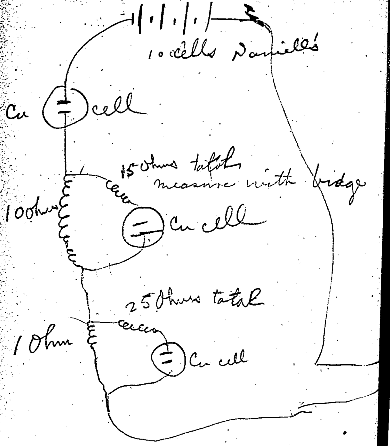
5 cts. a day for interest per H. P.

Cord of wood $12

1 HP

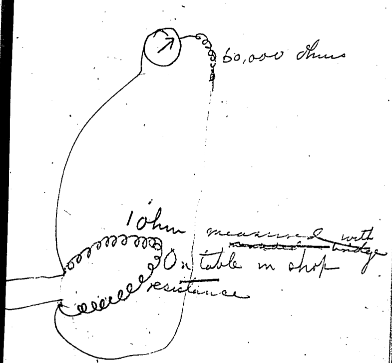

10 cells
Ohms
65 Ohms
1 Ohm on table in shop
60,000 Ohms
High resistance

Meter Exs.



Meter Exs.

100 = Deflection one Daniells circuit of high resistance closed on itself.



Copper No 1

50 5
10
2
.500
.200
.100
.50
.20
.02.5 OK

62.8725
63.2785

No 3

50
5
2
.200
50
20
10
6 1/3

57.286 1/3

Copper No 2

50
5
1
.500
100
20
10
10
7.5

56.6475
57.060

No 4

50
5
1
.100
50
20
1.75

56.171.75
56.574.75

63.2786
62.8725
.4060

57.475
17.1275
.40300

57.060
56.6475
.4125
.4060
.4030
1.2215
.4071 Grammes
4071 Millgr

18° to Three one

1 Standard Daniells 200 = D

D = 123

$R\ \frac{567}{100} - \frac{5}{100} = \frac{562}{100} = 5.62$ ohms R

.123 Daniells
.615 on 5.62 Ohm

.615
5.62

1.7889
0.7497
1.0392

.1095 Daniells on one Ohm

60 ⟌ 40.7.1 Mllg in one hour
6.785 Mllg in an minute
Comp. 1095 .9608
log 6.785 .8315
1.7923

.62. Mllgr in on minute
from one ~~Arster~~ Danielle of current!
on one Ohm!

62. 1.7923
comp 1.079 9.9670 -10
1.7593

.574 Mllgr one Weber.

Over ~~Siemens~~ 1.7593
.973 1.9881
1.7474
.559

Wiedemann on authority of
Bosscha states

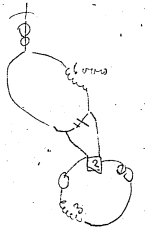
60 ⟌ 62
1.03 Mllgr.

.103 71/200 = .355
1.03
1065
355
.36565

.365 Mllgr ~~ta~~ from one
Daniells cells over

(77

.385
1.03
1155
385
39655



~~62/173~~ No 2 56694
56.658.5 ←
\+ .0355 gain

No 4 56.738.25
No 6 57.467.
No 2 56.6585. e.p.

No 6 57.467 ←
57.45475
− .00225 loss

56.776
56.73825
\+ .03775 gain

0
I.S.D. Def. 200. ~~Brass 755~~
~~Sl. + 166.~~

0.

I.S.D. Def 200. A current caused for a short time through the plates and measurements

Weight of Cu Plates

No 2 56.694

No 6 = 57.454 3/4

No 4 56.776

The plates put in solutions

No. 2 put in pure solution of Cu

No. 6 put in commercial Cu.

July 24 Niter Experiments

No 2. put in C.P. SO_4 Cu. lost 4.25 mgr

hours immersed No 6 Commercial Cu lost 4.25.

No 4. " " " 2. mgr

Added ammonia to the solutions and filtered.

Plates immersed Hours

No 2 in C.P. SO_4 Cu 3.25 P.M.

No. 4 in commercial 6. P.M.

No. 6 " " 6. P.M.

No. 6. Lost 1.5 mg ~~after again~~

No 2 " " 18.75 mg, " "

112

113

July 24

no 6. 56.832

no 7 53.253.5

100 Volts $\frac{100^2}{100} = 100$

100 Ohms

150 Ohms

X Volts

$\frac{X^2}{150} = 100$

$X^2 = 15,000$

122 Volts

4.1761

2,0880

34	33	.034	.034
34	33	34	.033 ½
34	33 ½	33 ½	
34	33 ½	33	.034
	~~33~~ ½	~~33~~ ½	.034
		33 ½	

34
34
33
33
4)134
33 ⅔

33 ⅔

Cu wire

186.5 Ohms 200 feet

~~.03305~~ 0.0335 in = diam

July 29 1879

Having deposited copper on copper foil, set the three in operation.

No 1 weight 23.464 was put in a Solution of sulphate of copper (commercial) at four P.M.

No 2 was also put in a solution of Sulphate of copper. com in which there was a little ammonia added, at 6. P.M.

No 3 was put in a C.P. Solution of Sulphate of Copper at 8 P.M.

15

15 Volts

Lamp 1 Ohm
1,5 Ohm in tire

2.5

15
15
75
15
22.5
4
900

44.3
9
3547
3547
2
5 | 7094
1419

1 Ohm
1.2 [illegible]

| 225
11.25
44.3

2.0511
1.6464
3.6975

| 4983
2491

4.5185
3.6975
.8210

2 Ohm 3 | 225
1 75
44.3

1.8751
1.6464
3.5215

| 3323
1107
2216

$4\overline{)225}$

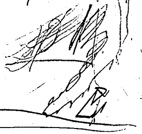
56.25

1.7423
1.6464
3.3887

$\overline{)2448}$

612

1836



$8\overline{)33000}$

4125

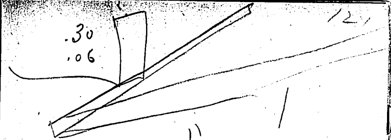
5

20625

772

4.3144
2.8876
1.4268

26.7



.30
.06

$\frac{1}{100}$ $\frac{1}{10000}$

100

$\frac{1}{4}$

100
200
20000

$\frac{1}{2}$ Ohm

$\frac{1}{4}$ $\frac{1}{16}$

2

$\frac{1}{2}$ Ohm

$\frac{1}{2}$ $\frac{1}{2}$

4430

6 | 33000

1) 5500   3, 7400

16   1.

| 5500

| 1375

344

8

.8   64   1.8062

1.6   1.6   0.2041

1.6021

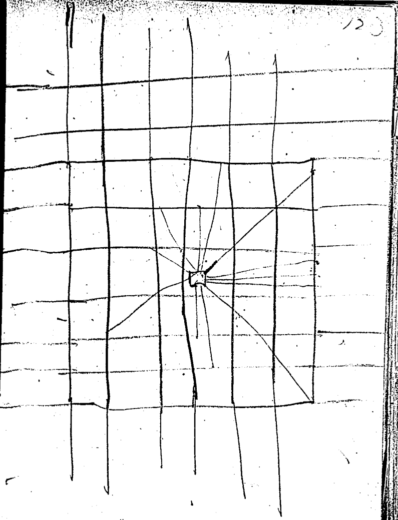
443   1.6464

3.2485

| 1770

885

442



18 inch

2 candles 800 ft. lbs

2000 foot lbs

75
.75
355
525
5605
2802

2802
443

3.4475
1.6464
5.0939

124000

5.0739
4.5185
.5754

3.76 H.P.

75/4
3.0.

1.00
1.33
.9
2.23

2.23

83 1.9194
83 1.9194
Comp 2.23 9.6517
log 44.3 1.6464

137000 5.1369
9.6517
4.7886

61,400

.75
5
37.5
1.25
1.25

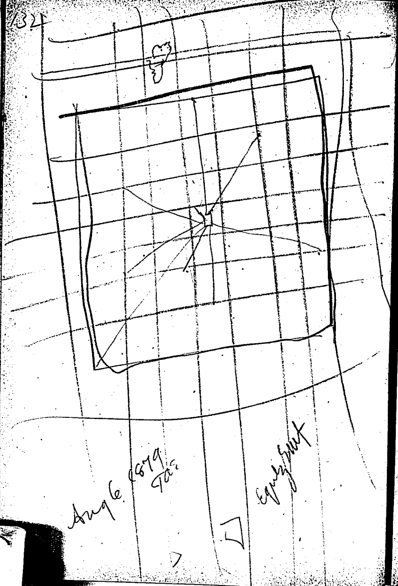
85
83

83 1.9194
83 1.9194
2.15 9.6676 -10
44.3 1.6464

142000 5.1528
9.6676
4.3264?

66,100

5,1528


Angle

(L + Z)

Iron Sulphide and dioxide

Ferrous sulphide

Aug 1

Battery

FeS + 2 C plate one plate covered with a piece of blotting paper soaked in a solution of NH_4Cl. gave a def on D. of 68° at 9 oclock

Aug 2 2 am

gave a def of [illegible]°

at 9 am of about 43°

[illegible] in the wet way

Aug. 3, 5 P.M.

Def. 75°

11

2 Cholorride of Silver Battery

Measured the internal resistance; found it to be about eight ohms, it gave a deflection on the Tang. Gal of $1\frac{1}{2}°$ which $= \frac{1}{8}$ of a weber. put it on short circuit all night, gave a def of 58, in the morning Aug 5 it gave a deflection of 48°: after this she fell to about 15° Deg.

I also measured the Electro motive force, which = about .9 of a danielle

 Aug 6 1879

Test of Latimer Clark battery. Constructed the battery as follows

In five small jars I put in about one quarter of an inch of mercury (Hg) on top of this I put a paste made of Mercurous Sulphate (H_2SO_4) and Sulphate of Zinc. ($ZnSO_4$). four of the batteries contained the Mercurous Sulphate made by dissolving the mercury in nitric acid and then precipitating. The Mercurous nitrate $Hg_2(NO_3)_2$ with Sulphuric acid.

---

one contained the Mercurous sulphate (Hg_2SO_4) made by dissolving the Mercury (Hg) in sulphuric acid

---

T. 80° F. = (26.2/3° C)

Elements			
No. I.	Internal R.		7. ohms
* " II.	"	"	13. "
" III	"	"	4.7 "
" IV	"	"	5.[illegible] "
V	"	"	5.7 "

* This Element contains the Mercurous sulphate made by the Sulphuric process.

Gravity 1.44

No. 1. Daniells 150 L 153 R
149

No. 2. 150
149

3. 150
149

4. 150
148.5

5. 150
14[illegible]

(H_2SO_4)

No. 1 161.8 L 185 R
186

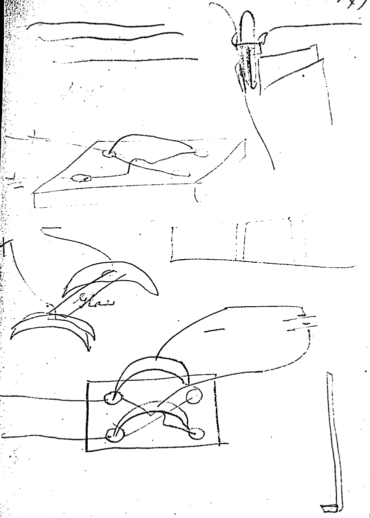
No 2 Sulphuric acid 188 L. 193

No. 2 against Standard Daniell 38.[illegible] R

No 3 187 L : 192 R

No 4. 182.5 L 189 R

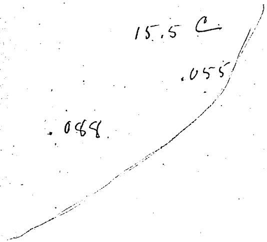
No 5 184 L 189 R



15.5 C

.055

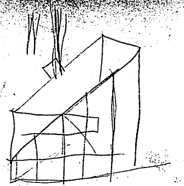
.088



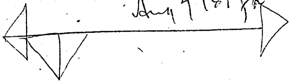
Test of Latimer Clarks
battery and remarks on [illegible]

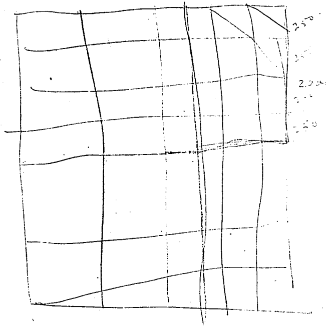
Test of ClAg Battery
Aug. 7

gave an internal resistance of 13 ohms. and an electro motive force of one Daniells. put it on short circuit. gave a deflection 45°
at one oclock it gave a def. of ~~[illegible]~~ 58° showing that it has increase about halfpast three oclock it was at 57° at about half past four 45°, put her off + ~~[illegible]~~ letting her remain for a day when put on short circuit again she gave a def of 25° went down to about 5° at 8 P.M.



Aug 7 1879





Test Aug 8

Test of $FeS + CaCl_2 + O_2$ Battery. Its electromotive compared with a daniell, = .88 of a Daniell Internal Resistance of about two hundred ohms)
Put him on short circuit at eleven o'clock it gave a deflection of 42° at quarter to twelve it gave a def of 30° when I came back from lunch it gave a def of 61° at eight P.M. 60° at about ten am Aug 9 it gave a def of 57

$\frac{132}{150}$ $\frac{130}{146}$ 66

150) 13200 (.88
1200
1200
1200

$\frac{80}{150}$ $\frac{80}{75}$ (.53 1/3

$\frac{80}{150}$) 800 (.5
750
50

774

 Aug 7 Gaiffe Battery
Compare with the Daniell
it equals to about .5 of a
Daniell Internal R. 6 ohm
put her on short circuit
at eight o'clock AM
& gave a def of 55°. at
ten Aug 9 gave a def of
45°

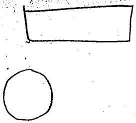
agel.
Measured the whole
set of 8 elements gave
a internal R of .54 ohm
Compare with the daniell
they = to .88 played out
in the morning after being
on short circuit all night

Aug 10

two Daniell Battery
10 ohms internal R
when first put up.
Its electromotive was
99.5 of a daniell. put it
on short circuit

Aug 13

tested internal R gave R of
260 ohm.



Wallaces

Wire No. 1. Sept 76

0.03 Ohm

49 feet 3 inches

.1341 in diameter

	.03	$\bar{2}$.4771	
comp	49.25	8.3076	
	134.1	2.1274	26
	134.1	2.1274	.003824
		1.0395	
		74	
	10.95	21	

79 / 9)395 / 4

79 / 32 / 47 / 9)235 / 26

1.4150
$\bar{3}$.5825
$\bar{2}$.9975

1.0994 .0414

9.718 / 1.0994

0.9876 / 0.0414 / 1.0290 / 53 / 37 / 1.0395

9.718 / 9.94 / 19.658 / 9.829

10.68

97.6 annealed $\bar{1}$.9895

.9926 / .0414 / .0340 / 0.395 / .9955

9.94

.9974 / 0.6414 / 1.0388 / 1.0395 / $\bar{1}$.9993

99%

99.9%

Wire No. 2

.004

53. feet 8 inches

.1205

	.004	$\bar{2}$.6021
comp	53.66	8.2705
	120.5	2.0809
	120.5	2.0809
comp	1.0994	9.9586
		.9930

9.84 ~~984~~ ~~9.84~~

.9926 / .9930 / .9996

99.9%

0.07 Ohm

5 7 feet 11 inches

72)110 9.16
108
20

.094

.07	$\bar{2}$.8451
comp 57.92	8.2371
94	1.9731
94	1.9731
	9.9586
	.9870

9.70

0.12 Ohm

5 7 ft. 11 in

.0725

.12	$\bar{1}$.0792
57.92	8.2371
72.5	1.8603
72.5	1.8603
	9.9586
	.9955

9.90

100%

156 Jerrip. 767

59 feet 4 ½ in

0.19 Ohms

.0575 inches

.19	$\bar{1}$.2788
amp 59.35	8.7734
57.5	1.2266
57.5	1.7597
	1.7597
	9.9586
	.9834

9.63	.9955
	9834
	10121

103 % Feet in mile 5280

9.829

157

9.718
9.940
19.658
9.829
5.280

.2064
.2106
2 | 4170
0.9923 2085

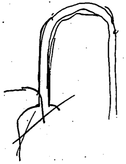
9.829
.4770
$\bar{1}$.6201
1.3722

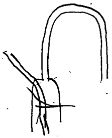
foot Cu .111 in long weighs 23.5 grains

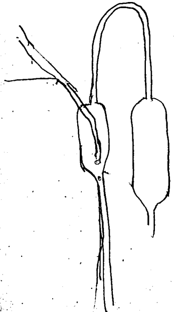
1.3722
3.5451
$\bar{3}$.5271

zero

ohms per foot $\bar{3}$.5271







Horse

$5x - 6y + 4z = 15$

$7x + 4y - 3z = 19$

$2x + y + 6z = 46$

$12x + 6y + 36z = 276$

$17x + 40y = 291$

$8x + 4y + 24z = 184$

$x + 27z = 165$

$16x + 13z = 96$

432
13
419) 2544 (6
2514

27
16
162
27
432

165
16
990
165
2640
96
2544

$5x - 6y + 4z = 15$

$7x + 4y - 3z = 19$

$2x + y + 6z = 46$

$14x + 8y - 6z = 38$

$16x + 9y = 84$

$15x - 18y + 12z = 45$

$28x + 16y - 12z = 76$

$43x - 2y = 121$

$16x + 9y = 84$

$387x - 18y = 1089$

$32x + 18y = 48$

$x = 3$

$419x = 1257$

419) 1257 (3
1257

$-2y = 121 - 129 = -8$

$y = 4$ $z = 6$

aug

Put two coppers no 8. (24.387½) and no 10 (28.368) and also no 9 (22.427½) and no 6 (29.001¼) in a solution of Sulphate of Copper, mixed with Rochelle salts dissolved in Caustic Soda

aug 28

after leaving the coppers a few day in the above solution the results were as follows.

no 10 weight 28.352⅔, which is ~~11~~ 5⅓ mg less, no 6. 28.998½ which is 2¾ less.

no 9 22.426⅓ which is 1⅙ mg less

no 8 ·24.379¾ which is 7¾ mg less

aug 29

Put the copper in the solution again with a

current of 2 ~~cells. at~~
10 am. I had them
in untill half past nine
the next morning. Took
them out & let them
dry, and had Kelley
to weight them. the weights
were as follows,

no 6 ~~28.998 3.3~~ 33.123[illegible]
before putting it in The
Solution it weight 28.998[illegible]
showing an increase in
weight of $4.124\frac{4}{6}$
no 10 $24.469\frac{1}{8}$ before
puting it in the solution
it weight $28.352\frac{2}{3}$ showing
a decrease in in weight
of $3.883\frac{13}{24}$

---

no. ~~8~~ 9 $26.563\frac{7}{8}$ before
puting it in the solution
it weight $22.426\frac{1}{3}$ showing
an increase of $4.137\frac{13}{24}$
no 8 20.392 before puting
it in The solution it weight
$24.379\frac{3}{4}$ showing a
decrease of $3.987\frac{3}{4}$

Those which had a
decrease in weight had
on taking them out a
soapy surface yellowish
green, while those which
had an increase had
a dark brown color on
one side while on the
other side half way down
it had the same color the
other half being the bright copper color

 Sept. 2, 1879

Put no 6 & 9 in a solution cu & NH_4 or $Cu(NH_4)_2(SO_4)_2$ at noon. No 6 weight 33.108¼ and no 9 weight 26.545⅓.

In one mile how much weight of wire?

Sprague.

¼ inch 189.07 lbs. in 1000 feet
" has resistance of 0.1654 Ohms

~~189.07~~

Mile 5.28 .7226
.1654 $\bar{1}$.2185
$\bar{1}$.9411

~~$R = \frac{L}{W}$~~

~~$.95 = \frac{L}{W}$ $WR = L$~~

189.07 2.2767
$\bar{1}$.9411
2.2178
.7226
2.9404

165
872.

$$R = \frac{l}{S}$$

$$W = l\,S$$

$$S = \frac{W}{l}$$

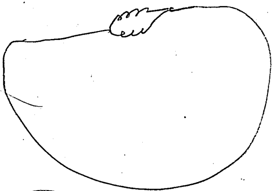
$$R = \frac{l}{\frac{W}{l}} = \frac{l^2}{W}$$

$$1\ \text{Ohm} = \frac{(6046.5)^2\ \text{feet}}{}$$

$$WR = l^2 \qquad R = d$$

$$dW = l^3$$

$$W = \frac{l^2}{R}$$



Portland

Beekman St NY

Lawson will make a solution a Cu. Sulphate and put Oxide of Cu. into it. You will try it and see how it works. Get Lawson to write what he does and help him.

No. 4	27.054	7
5	20.599	3
No. 8	18.945	12

Nov. 8 1879

~~20.70~~

No. 4	27.047	27.047	0.0
No. 5	19.885	20.582	.697
No. 8	18.250	18.933	.683
No. 10	22.474	22.488	.014

Put in soak in Solution No. 1

100 Ohm lamps 10 per Horse power

$C^2 R$ ~~R~~ $44.3 = 3300$

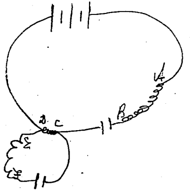
$C^2 = \frac{33}{44.3}$

	1.5185
	1.6464
	$\bar{1}$.8721
.863 Webers	$\bar{1}$.9360

Measure the resistance of cells by means of the high resistance Galva.

The current may be measured by dividing the E.M.F. on AB by the resistance of AB.

The ~~shunt~~ resistance of the shunt DC will be to the resistance of AB as ~~deflection~~ E.M.F around DC is to the E.M.F around A & B.



No. 1 Solution

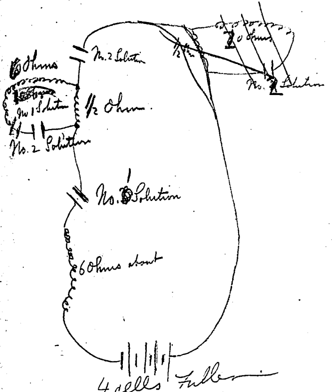
Copper Sulphate C.P

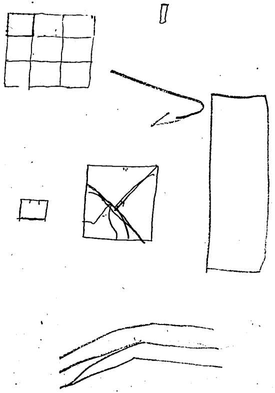
"Just enough ammonia added to neutralize any free acid if any were present." Lawson

---

No. 2 Commercial Copper Sulphate

No. 1 worked very well plates in it 36 hours gained in two cases 7 & 12 mg. and Cast in another 5 mg. showing so far as the care was taken no change



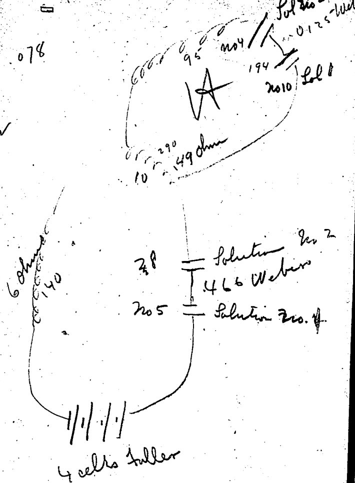


12.

184

.078

3/32



Current started at 5 0 5

2 — 45 P. M. (my watch)

Made 4 cells of Daniells 216

50 deflection = 1 Volt

$\frac{140}{50}$ = $\frac{2.8 \text{ Volts}}{6 \text{ Ohm}}$ = ~~4.66 W~~ .466 Webers

around 6 ohm

$\frac{119}{140}$ X6 = ... = $\frac{3}{7}$ = .428 Ohms

$\frac{119}{50}$ $\frac{119}{140}$ X 6

119 × 3 = 357; 357 ÷ 70 = 5.1 Ohms

188

305) 300.9 (.983
2745
2540
2440
1000

300 : 48 :: 305 : 49

101.66
.48

15

300 on 3.05 .49 Ohm
48 on X shunt
x = .49 Ohm

290 on X shunt
95 on 6 Ohm in
194
289

2
95

.466 Weber
Let x = No divisions / Volt

$$\frac{290\frac{1}{x}}{.49} = .466$$

$$\frac{1}{x} = \frac{.466 \times .49}{290}$$

$$x = \frac{290}{.466 \times .49}$$

1270

2.4624
10.3316
10.3098
3.1638

Plate

95
1270
6

1.9777
6.8962
9.2218
$\bar{2}$.0957

.0125 Webers flowing in Branch A p. 184

.466
.0125

$\bar{1}$.6684
$\bar{2}$.0957
1.5727

37 times the resistance ~~as~~ in Branch that there is in Shunt or it is equivalent to that amount in holding back the E.M.F.

Test 75 minutes

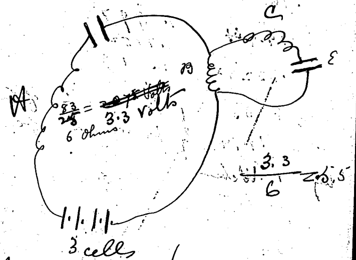
	697 mg	2.8432
comp	75	8.1249
comp	.466	10.3316
	19.94	1.2997
		1.7782
	.3324 mg	1.5215

Deposit .332 mg per second of Cu.

" 19.94 mg per minute of Cu.

by 1 Weber

Nov. 11, 1879



A 300
B 48.5

B 311 – 312
B (C open) 330
C 212
E 97

3.3/6 = ~~.345 Webers~~ .55 Webers

~~330~~ $\frac{311 \times \frac{1}{x}}{.49} = .345$

$x = \frac{.49}{311 \times .345}$

$= \frac{311}{.49 \times .345}$

1.6902
7.5072
10.4622
3.6596

2.4928
10.3098
10.4622
3.2648

1840
~~922~~

$\frac{212}{1840 \times 6}$

2.3263
7.6352
9.2218
8.5833

2.3263
6.7352
9.2218
8.2833

.0383

[illegible] .0192

3.458
30.3

2.5378
1.5833
.9545

.345
.019

1.5378
8.2833
2.2545

[illegible] 18.

194

8 cells

4 cells standard ~~to~~ 108.

A 125

B (C. open) 49.5

1/2 A 3 ohms 300.

B ~~326~~ (C open) ~~3.26~~

B (C closed) 308.5

C 214

214	2.3304
1208	3.0820
177.6	1.2484
	0.7782
	2.4702

~~4/125/~~ 125/300 Volts on 6 ohms

~~6/300/12 Volts on 6 ohms~~ 6 ohms

~~.521 Webers~~ 5/6 Weber

$\frac{308.5}{.49} \times \frac{1}{X} = .521$

$X = \frac{308.5}{.49 \times .521}$

2.4895
10.3098
10.2832
3.0825

1208

521 2.7168
1.4702
1.2466

17.6

195

8 cells

4 standard 108

A 90 around 3 ohms

B 335

C 239

~~1 mag in case~~

196

I mg in a minute per lamp

60 mg per hour

ten lamps

600 mg per hour

Francis R. Upton O.K.

197

Meter box made May 1879 tried Nov. 14 1879.

Resistance shunt .14 Ohm

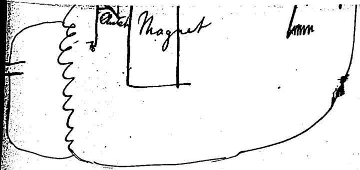
Remainder about .06 Ohm

Edison Laboratory Note Book No. 35.

Pages 197 and 198.

Electric Meter.

See Edison Patent:
251,545 (Pat. Dec. 27, 1881.)



1 mg in a minute per lamp.

60 mg per hour

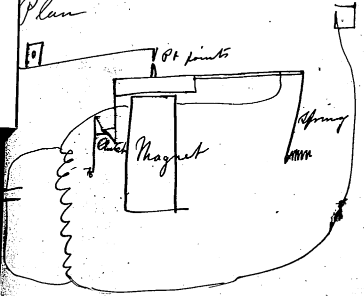
Meter box made May 4 1879 tried Nov. 14 1879.

Resistance shunt .14 ohm

Remainder about .06 ohm

~~Plan~~ Magnet .015 ohms

Plan



198

The magnet ~~was~~ strong and broke the current at about ten Webers or less. The ~~jump take~~ arc between the break points kept up for some time after the magnet had clutched

The magnet changed so that the armature was placed nearer the hinge so that the spring would count more and the end would open more

Meter experiments Nov. 15. 1879 199

For shunt $\frac{1}{10}$ Ohm

Pages 199 to 282. "Electro-deposition Meter Notes."

.03	.03	.10	.15	.20

Currents ~~1/4~~ 3 Weber ~~15~~ Webers

Edison Laboratory Note Book No. 25.

Pages 198 to 282.

See Edison Patents:
304,082
303,485
281,352
251,545
240,378

5.16
6.02
6.88
7.74
8.60

The magnet so strong
and broke the current

or less. The ~~jumps take~~
[illegible] than the break

nearer

spring would count more and
the end would open more

Meter experiments Nov. 15. 1879

Try shunt $\frac{1}{100}$ Ohm

.03 .03 .10 .15 .20

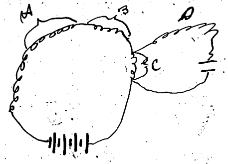
Currents ~~3/4~~ 3 Weber ~~7.5~~ Webers

~~2.25 Webers 3. Webers~~

~~3.75 Webers~~

.86 Webers
1.72
2.58
3.44
4.30
5.16
6.02
6.88
7.74
8.60

9-10 Shunt $\frac{1}{100}$ Ohm



A = 3.1 Ohms
B = .5 Ohm
D = 6 Ohms

25)61(2.44
50
110
100

3)2.44
.81

25)65

A = 65

A = 65

25)65
3)2.6 Volts
.86 Webers

$\frac{18\frac{1}{x}}{.01} = .86$

$18\frac{1}{x} = .0086$

$x = \frac{18}{.0086}$

1.2553
3.9345
3.3208
2090.00

C = 18

D = 9 over 6 Ohms

9)2090
232
$\frac{1}{1000}$ weber

A = 105

C = 31

D = 10 over 6 Ohms

~~A~~ 2 cells 108

B 56 1/2 A $\frac{56}{54} \times 2$ 54)112 (2.08 / 108 / 400

2.08 Webers

C 48

D 15

B 95 $\frac{95}{54} \times 2$ 95 / 2 / 54)190 (3.7 Webers / 152 / 380 / 378

C 75 $\frac{123}{73}$ 2.0899 / 1.8633 / .2266

D 29

1.68

Nov. 17 1879 ABCDEFGH

~~A 178~~ C = .05

~~A 169~~

2 cells 108 D = 50 for 1 Volts

B 1/2 Ohm

~~39 on A~~

35 on B

5.135 / 2 / 1.4 Webers

93)123 (1.68 / 73 / 500 / 438 / 620

~~C 130~~

D = 73

C = 123

$\frac{C \times \frac{1}{x}}{.05} = 1.4$ $x = \frac{C}{1.4 \times .05}$

$\frac{1}{x} = \frac{1.4 \times .05}{C}$

.070)123.00 (1757

73 1.8633

1757 3.2430

1.4 1461 2.6203

6 0.7782

3.8421

.00695 1.4 .1461

202

~~4963~~ ratio ~~2.3040~~ ~~3.6966~~

108 Two cells

108 on A

~~2.04~~ Volts
~~1.68~~ Webers

108
216

2.16
.72 Webers

C_0 59 1.7709 / 1.4914 / .2885
A 31 1.94

c_e = .05 Ohm

31) 59 (1.90
31
280
279

.68
.05
.0340

034) 59000 (1760
34
250
238
120
204
160

.72
.05
.0360

59. 1.7709
.036 $\bar{2}$.5563
3.2146

1600

31 1.4914 .72 $\bar{1}$.8573
Comp 1600 6.7854 $\bar{3}$.4986
Comp. 6 9.2218 2.3587
3.4986

.00315 229

108 Two cells C = .05 ohms

A =50 (14.8
3 (2.9.6
.987 Webers

44) 79 (1.79
44
350

C = 79 8976 / 6435 / .2341 171
D = 44

.487
.05
.04935

40.8
90.8

79 1.8976
.0493 $\bar{2}$.6928
3.2048
1600
~~1970~~

~~1.48 : 108 : 59 :~~
108 : 148 :: 59 :

2.1703
1.7709
7.9666
1.9078

80.8

.68 : .987 : 59 :

$\bar{1}$.9943
1.7709
10.1675
1.9327

85.5

B = 52

2 Webers

C = 170
D = 104) 170 (1.65
104
680
624
555

C = ·03
Page 210

A = 194
188
6

C = 41
D = 20
2.05 Ratio

A = 131
3)2.62 Volts
.873 Webers

03) 5600
1866.
6
11,196

29)11,196

1.4624
4.0487
3̄.4137
.873 1̄.9410
3̄.4727

.06297

C = 56
D = 29) 56 (1.85
29
270
252
180

see Book 26 p. 213

C = .03 Ohm

B = 50 2 Webers

C = 120
D = 62) 120 (1.80
62
580
576
4

B = 51 C = .01 Ohm

51
2
204 Webers

C = 49
A = 25) 49 (1.96
25
240
225

C = 01

A = 102

C = 260
A = 105) 260 (2.38
210
400
315
850

10

1500 lamps 1500 hours in a month. 1 Gramme per lamp

150000 3000 ft. lbs

60

180,000

1500

900000000

18

270,000,000

1500

2,700,000

300

10 Grammes

Say $\frac{1}{250}$ of the current in the main line flows through the shunt containing the voltameter

10 per H.P

$\frac{X^2}{100}$ 44.3 = 3300

$X^2 = \frac{330000}{44.3}$

5.5185
8.3536
3.8721
1.9360

X = 86.3 Volts

.863 Webers flowing

Page 191

19.94 Mg. of Cu. by one Weber in one minute

19.94
60
1196.40 Mg per hour
1.1960 Gr per hour

24 hours a day

30 days a month

120 hours

~~150~~ hours

1.19 0.0755

150. 2.1761

2.2516

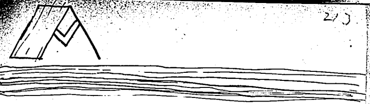
178 ratio of Shunt

$\frac{1}{178}$ of Current should go through the shunt

1000/178

150 hours

200 hours



$\frac{1}{178}$ of current should go

180

5

750 feet per month

750 5cts an hr

25 30 $7.50 $7.50

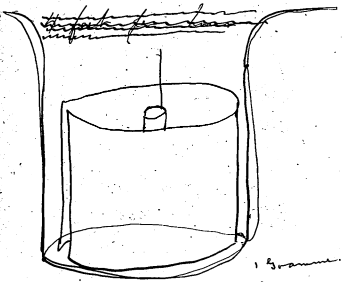
$7.50 $7.50 $7.50

750 feet per month

1 Gramme represent one thousand feet of gas

Supposing that ~~the~~ a burner consumes 5 feet ~~for~~ per hour

200 hours



1 Gramme

1 Gramme

1 Gramme Gramme — 1 Gramme

1 Gramme

1 Gramme — 1 Gramme

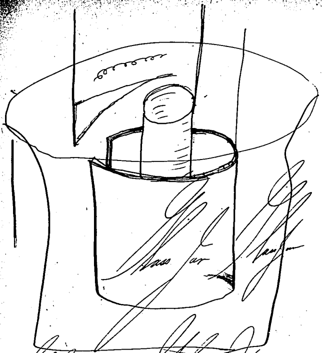
1 Gramme — 1 Gramme

1 Gramme — 1 Gramme

1 Gramme — 1 Gramme

1 Gramme — 1 Gramme

1 Gramme



Glass jar Glass jar

Glass jar small battery

resistance 2 Ohms

Coiled copper

Glass jar

Fran Fr Immortal

Francis R. Upton
Francis R. Upton Francis R
Francis R. Upton Francis R. Upton
Fran Francis Francis Fran
Francis R. Upton
Francis R. Upton Francis R. Upton
Francis R. Upton Francis R. Upton

Meter Meter Meter

500 ft feet to a burner

500 4 " .003 .03

500. 200 hours

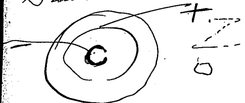
1.19
200
238.00

238 ratio

.03 3 6 times
.05 five lamps
.03 ten lamps
.015 twenty lamps

1 Gramme of Cu

Standard cell



Red Red wire +

Green Green wire

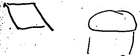
Red wire Green wire -

Red wire Green wi

Cell can be made of
certain size Must be sealed
how Metal cover

Copper does not creep much
Copper does not creep much

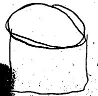
Two poles are needed

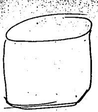


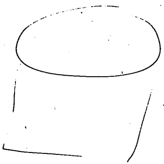
Red and Green
wires

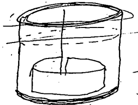
.03 Ohms for shunt Measure
wire and wind on magnet
.03 03 safety clutch

03 3333333 3333









~~Tools~~
~~Attwoods~~

~~Attwoods Tools~~

Francis R Upton
Francis R Upton
Francis R. Upton
Francis R. Upton
Francis R Upton
FF
Francis R Upt
cis R. Upton

Make a jar and resistance
on magnet .88 so that
with .03 in shunt $\frac{1}{238}$ of
the current ~~from~~ two to two
lamps will pass through the
meter.

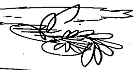
Do make 8

Better take near 03 and

A coil so wound as to be easy
of adjustment .03 .03 .03 .03 .02 .02 .
.02 .03 .03 .03 03

Every cu. foot of gas
will be measured by a
mg. 1000 ~~mg~~ = 1 Gr.

Motor sold the same as
light



20 Ohm motor
100 Ohm lamps

Dec 1st, 1879.

30 grams pure sulphate copper in 300 c.c. distilled water.

Bottles = (Dec. 14)

No. 1, 100 c.c. solution to which was added [illegible] c.c. aqua ammonia, then filtered, ~~poured~~ into bottle, heated gently to drive out air, copper placed in, and sealed.

No. 2 100 c.c. solution, fitered, poured into bottle, heated to drive out air, copper placed in, and sealed:

No. 3 100 c.c. solution, fitering, poured into bottle, copper placed in, and sealed.

(Note) The heat was continued after the plates were placed in the bottles, to drive out any air that might be taken into the solution by adherence to the plates.

Detached
Detached
Detached

(Dec 14)

No. 4 Distilled water slightly heated to drive out air, copper placed in and sealed

Attacked slightly

No. 5 10 grams pure copper sulphate together with 1 gram pure ammonium chloride and 1 gram copper carbonate in 100 c.c. distilled water

Attacked

No. 6 Same as preceding, only heated to drive out air —

Attacked

No. 7; 10 grams copper sulphate and 1 gram copper carbonate in 100 c.c. dist. water —

Attacked

No. 8 Same as preceding only heated to drive out air

Attacked

Dec 3, 1879

No. 9 10 grams sulphate copper in 100 c.c. dist. water & several pieces,

copper placed in bottom
Set this away for one week
then place in strip of polished
copper. The action ~~that~~ is
set up between the solution
and copper may satisfy
itself on these small pieces,
and then when the strip is
introduced there will be no
further action.

No, 10
10 grammes ~~Alc~~ ~~sulph~~ copper chloride
in 100 cc. Alcohol.

No. 11, Dec. 4, 1879 ~~Alcoholic~~ Acid solution double
sulphate copper and ammonium.

No. 13 Dilute solution cupric sulphate
Wallace copper (electrotype)
Weight of plate in = 2.522
Taken out Dec. 9, 1879 — Weight = 2.517

2582
2575
.007

2.522
2.517
.005

2.582 : 2.522 :: .0107 : X

.007

2582) .017654
15492
21.62.0

.006

No. 14 Dilute solution double sulphite copper and ammonium. Wallace copper (electrotyped) Weight when put in = 2,582+ — Dec. 9, 1879 — weight = 2.575
Dec. 5, 1879

No. 15 — Cup is ~~attacked~~ acted in solution either

~~No. 2 acted on the least~~

No. 2 acted on very slightly
No. 11. acted on scarcely at all
No. 12 very little more than
No. 11 -

No. 11 least

Copper sulphate solutions
for electro-deposition

~~Saturated~~ solution

No. 1	2 parts ^ sulphate	to 1 water	
No. 2	1 pts sulphate	to 2 water	
No. 3	1 pt. "	to 4	"
No 4	1 " "	to 8	"
No 5	1 " "	to 12	"

Weight of copper plates before put in solution and current passed through them

No. 1 = 15.584
No. 2 = 16.165
No 3 = 15.400
No 4 = 16.852
No 5 = 16.293

Weight of copper plates after placed in solution and current passed through them.

No. 1 = 16.1271
No. 2 = 16.723
No. 3 = 15.953
No. 4 = 17.403
No. 5 = 16.845

Difference between the weights of two plates before and after placed in solution and current passed through them –

No. 1 = [illegible] – 15.680 = .547
No. 2 = 16.723 – 16.165 = .558
No. 3 = 15.953 – 15.400 = .553
No. 4 = 17.403 – 16.852 = .551
No. 4 = 16.845 – 16.293 = .552

Double sulphate copper and ammonium – solution of different strengths –

No. 1	2 pts	sat.	sol.	to	1	pt	water
No. 2	1	"	"	"	2	"	"
No 3	1	"	"	"	4	"	"
No 4	1	"	"	"	8	"	"
No 5	1	"	"	"	12	"	"

Weight of copper plates before placed in solution and current passed through them

No. 1 = 15.802
No. 2 = 16.442
No. 3 = 15.692
No 4 = 16.588
No 5 = 17.020

Difference between the weights of the plates before and after placed in solution and current passed through them -

No. 1 = 16.807 − 15.802 = 1.005
No 2 = 17.462 − 16.442 = 1.020
No 3 = 16.707 − 15.692 = 1.015

Nos. 4 and 5 N.G. the copper deposited on them was spongy and washed off when cold water was applied to them -

Cupric Chloride gave no satisfactory results

Cupric Nitrate

No. 1, 2 pts strong solution to 1 pt water
No 2, 1 pt " " to 2 " "
No. 3, 1 pt " " to 4 " "
No. 4, 1 pt " " to 8 " "
No. 5, 1 pt " " to 12 " "

Weight of plates before placed in solutions and current passed through them.

No. 1 = 15.313
No. 2 = 15.189
No. 3 = 17.353
No. 4 = 16.697
No. 5 = 17.024

Difference between the weights of plates before and after placed in solutions and current passed through them —

No. 1 = 16.304 − 15.313 = .991
No. 2 = 16.189 − 15.189 = 1.995
No. 3 = 18.348 − 17.353 = .988
No. 4 = 17.685 − 16.697 = .98[illegible]
No. 5 = 18.010 − 17.024 = .986

Solution

1880

Double sulphate — Copper and Ammonia.

No.	Date.	Time.	Weight.	Remarks —
1	Jan. 19	9 P.M.	28.645	4, 5 and 6 supersaturated solutions —
"	" 20	9 A.M.	28.633	
"	" 20	12 P.M.	28.619	
"	" 21	9 A.M.	28.615	1, 2 and 3 saturated at ordinary temperatures,
"	" 21	9 P.M.	28.610	
"	" 22	9 A.M.	28.605	
2	" 19	9 P.M.	29.413	
"	" 20	9 A.M.	29.400	
"	" 20	12 P.M.	29.392	
"	" 21	9 A.M.	29.387	
"	" 21	9 P.M.	29.383	
"	" 22	9 A.M.	29.379	
3	" 19	9 P.M.	28.030	
"	" 20	12 P.M.	28.009	
"	" 22	9 A.M.	27.997	
4	" 19	9 P.M.	28.125	
"	" 20	12 P.M.	28.096	
"	" 22	9 A.M.	28.082	
5	" 19	9 P.M.	29.851	
6	" 19	9 P.M.	30.100	
1	" 22	9 P.M.	28.595	
2	" 22	9 P.M.	29.373	
"	" 23	9 A.M.	29.368	
1	" 23	9 A.M.	28.590	
4	" 23	9 A.M.	28.069	
3	" 23	9 A.M.	27.985	
2	" 23	9 P.M.	29.363	
1	" 23	9 P.M.	28.583	
6	" 23	9 P.M.	30.026	
5	" 23	9 P.M.	29.790	
2	" 24	9 A.M.	29.357	
1	" 24	9 A.M.	28.577	
3	" 24	9 A.M.	27.979	
4	" 24	9 A.M.	28.060	

To be considered. The strength of the solution; that in one series of experiments the solutions in all the bottles are of equal strengths. A plate of remaining in contact with the solution for a considerable length of time the liquid in immediate contact with it not being disturbed is not affected in the same degree as one ~~that~~ which is being disturbed frequently has its surface exposed to ~~fresh~~ undisturbed layers of liquid; the liquid surrounding the plate becomes saturated by its action on the plate and has its capacity for action diminished accordingly, so that ~~beyond certain limits~~ for x time there is a constantly decreasing action commencing at x and approximating to 0; whereas in the other case for fractions of x time the loss for each fraction equal within certain limits —

The condition of the surface, rough

Solution
Double sulphate copper and ammonia.

No.	Date.	Time.	Weight.	No.	Date.	Time.	Weight
7	Jan 24	8 AM	14.587	1	Jan 26	9 AM	28.552
8	"	"	7.328	2	" "	" "	29.340
9	"	" "	3.860	3	" "	" "	27.962
10	"	" "	10.417	4	" "	" "	28.037
11	"	" "	5.631	1	" "	9½ AM	28.546
12	"	" "	3.260	2	"	" "	29.335
13	"	" "	7.716	3	" "	" "	27.957
14	"	" "	4.136	4	"	" "	28.029
15	"	" "	2.311	7	"	8 "	14.558
1	" 25	12 M	28.567	8	"	" "	7.307
2	"	" "	29.349	9	"	" "	3.845
3	"	" "	27.970	10	"	" "	10.393
4	"	" "	28.050	11	"	" "	5.615
7	"	" "	14.573	12	"	" "	3.2475
8	"	" "	7.317	13	"	" "	7.697
9	"	" "	3.853	14	"	" "	4.122
10	"	" "	10.405	15	"	" "	2.3015
11	"	" "	5.623	7	" 27	9 AM	14.552
12	"	" "	3.256	8	"	" "	7.302
13	"	" "	7.706	9	"	" "	3.842
14	"	" "	4.128	10	"	" "	10.387
15	"	" "	2.306+	11	"	" "	5.612
7	" 26	8 AM	14.564	12	"	" "	3.244
8	"	" "	7.311	13	"	" "	7.692
9	"	" "	3.848	14	"	" "	4.118
10	"	" "	10.398	15	"	" "	2.2995
11	"	" "	5.618	1	"	11 AM	28.538
12	"	" "	3.250	2	"	" "	29.3285
13	"	" "	7.710+	3	"	" "	27.949
14	"	" "	4.125	4	"	" "	28.022
15	"	" "	2.303				

Nos 7, 8, 9, 10, 11 and 12 solutions were supersaturated, cooled to 60° F., and to 11 volumes ~~were~~ added one volume of water at the same temperature

Nos 13, 14 and 15 ^exact solutions were saturated at temperature 65° F.

~~Plates 7, 8 and 9 are rectangular 3 × 1½ in.~~
~~" 10, 11 and 12 are triangular~~

Plates 7, 8 and 9 are rectangular

$7 = 3 \times 1\frac{1}{2}$ in.; $8 = 3 \times \frac{6}{8}$ in.; $9 = 3 \times \frac{3}{8}$ in.

Plates 10, 11 and 12 are triangular

$10 = (4 \times 1\frac{1}{2})\frac{1}{2}$; $11 = \frac{1}{2}(4 \times \frac{6}{8})$ in.; $12 = \frac{1}{2}(4 \times \frac{3}{8}$ in.$)$

Plates 13, 14 and 15 are rectangular.

$13 = (1\frac{1}{2}$ in.$)_2$; $14 = 1\frac{1}{2} \times \frac{6}{8}$ in.; $15 = 1\frac{1}{2} \times \frac{3}{8}$ in.

for smooth — The comparative purity of the copper plates,

The quantity of liquid by which the plate is surrounded, also the relative position of the plate in the liquid; a plate may be immersed in a large quantity of liquid but so placed that its surface is exposed to the action of a comparatively small quantity; again it may be placed in a much smaller quantity of liquid ~~than in the preceding case~~ and yet have its surface exposed to the action of a comparatively or absolutely larger quantity than in the preceding case. Over

~~Data to determine the constant loss~~
~~copper plate in solution double sulphate~~
~~copper and ammonia~~ –
Data (Double sulphate copper and ammonia). (Solution saturated at temperature ~~40~~ 65°F.)

No.	Hours in solution	Weight.	Date–	Time
a	00	5.220	Jan. 27	8.30 P.M.
b	00	5.399	" "	" "
c	00	6.140	" "	" "
d	00	18.771	" "	9.30 P.M.
e	00	4.795	" "	" "
f	00	5.772	" "	" "
g	00	14.218	" 28	17.05 P.M.
h	00	14.462	" "	" " Pieces in solution
g	2	14.216	" 29	7.15 a.m.
h	"	14.460		Placed in solution
g	9	14.212	" 29	
h	"	14.456	"	10.35 A.M. Placed in solution
g	11	14.207	" "	9.45 P.M.
h	"	14.451	" "	
7		14.531	" "	8.30 P.M.
8		7.287	" "	" "
9		3.830+	" "	" "
1		28.508	" "	12 P.M.
2		29.310	" "	" "
3		27.927	" "	" "
4		27.998	" "	" "
5		29.726	" "	" "
6		29.943	" "	" " Placed in solution
g	11	14.203	" 30	9.00 A.M.
h	"	14.447	" "	11. A.M.
10		10.367	" "	" "
11		5.593	" "	" "
12		3.222	" "	" "
13		7.672	" "	" "
14		4.106	" "	" "
15		2.291	" "	" "

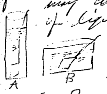
Remarks

a, b and c – relation between quantity of liquid and loss
surface of each = 3 in. = $(1 \times \frac{3}{2})2$
quantities of liquid:
a = 150 c.c.
b = 300 c.c.
c = 450 c.c.

d, e and f – relation between loss and surface –
Surface:
d = 12 in. = $(4 \times \frac{3}{2})2$
e = 3 " = $(4 \times \frac{3}{8})2$
f = 3 " = $(1 \times \frac{3}{2})2$

g and h – Data for constant loss –
surface:
g = 9 in = $(3 \times \frac{3}{2})2$
h = " " = "

for instance the vessel A may contain as large a quantity of liquid as the vessel B, but the amount of active liquid surrounding the plate in A is not so great as in B –



In order that a regular action may take place between the surface of the plate and the liquid in contact with it the metal surface must be chemically clean; it is necessary that great precautions be taken to prevent surface oxidation and it is known that such ~~action~~ oxidation takes place rapidly under ordinary circumstances, and especial care must be taken that the surface of the plate does not come in contact with anything of an oily nature –

The temperature must also affect the intensity of the action, as the temperature increases the intensity of action will probably also increase, as the temperature diminishes the intensity of the action will also probably ~~[illegible]~~ diminish –

No.	Hours in solution	Weight.	Date.	Time.	
g	*11	14.198	Jan. 30	8.15 P.M. Placed in solution	* The temperature higher during this last 11 hours than in the preceding cases - it will be noticed that the loss from g and h is greater for the last 11 hours than during the 11 hours preceding
h	"	14.449	" "		
a	72	5.208	" "	8.30 P.M.	
b	"	5.384	" "	" "	
c	"	5.123	" "	" "	
g	11	14.1935	" 31	Placed in solution	
h	"	14.4375	" "	8.30 A.M.	
g	12	14.189	" "	Placed in solution	
h	12	14.433	" "	7.45 P.M.	
a	43	6.199	Feb 1	8.30 P.M.	
b	"	6.376	" "	" "	
c	"	6.113	" "	" "	
d	144	18.716	" "	8.30 P.M.	
e	"	4.774	" "	" "	
f	"	5.7495	" "	" "	
d	*00	18.407	" "	Placed in solution	* d, e and f were washed in nitric acid before being replaced in the solution -
e	"	4.720	" "	12 P.M.	
f	"	5.713	" "		
1		28.471	" "	12 P.M.	
2		29.284	" "	" "	
3		27.901	" "	" "	
4		27.964	" "	" "	
5		29.688	" "	" "	
7		14.488	Feb. 2	8.30 P.M.	
8		7.258	" "	" "	
9		3.809	" "	" "	
d	24	18.392	" "	12 P.M.	
e	"	4.714	" "	" "	
f	"	5.707	" "	" "	

Take a plate of copper and clean it
by immersion in nitric acid, washing with water,
alcohol, ether, dry it and ~~it~~ then place in
the solution of double sulphate and at the
expiration of a definite time remove it and
clean by washing with water and alcohol,
then reweigh it; now make it chemically
clean in the same manner as at first,
weigh again and immerse in the solution as
before and at the expiration of the same
number of hours as in the first case take
it from the solution and wash as in the
preceding case and weigh ascertain the difference
between the two weights and compare
with the difference between the two
weights of the first case - repeat this
operation a number of times, making the
surface chemically clean, ~~each time~~ weighing
it, placing it in solution, at the expiration
of a definite period reweighing it,
making a note of the difference between
the two weighings, making the
surface chemically clean again and

No.	Hours in solution	Weight.	Date.	Time.
10		10.324	Feb. 2	12 P.M.
11.		5.573	" "	" "
12		3.214	" "	" "
13		7.648	" "	" "
14		4.090	" "	" "
15		2.279	" "	" "
g	48	14.160	" 3	7.45 P.M.
h	"	14.407	" "	" "
1		28.430	" 5	12 M.
2		29.245+	" "	" "
3		27.868	" "	" "
10		10.310	" "	" "
11		5.555	" "	" "
12		3.200+	" "	" "
13		7.631	" "	" "
14		4.076	" "	" "
15		2.268	" "	" "
d	60	18.359	" "	12.30 P.M.
e	"	4.698+	" "	" "
f	"	5.695+	" "	" "
a	96	5.178	" "	3.30 P.M.
b	"	5.352	" "	" "
c	"	5.085	" "	" "
g	24	14.135	" "	8.15 P.M.
h	"	14.372	" "	8 "
7		14.450	" "	8.30 P.M.
8		7.236	" "	" "
9		3.791	" "	" "

so on, after a number of determinations have been made in this way, compare the differences between each two weighings, and note the relation between the time and the difference.

The rendering of the surface chemically clean after each determination is to bring the conditions more nearly equal in each experiment, the taking out, washing and drying of the plates a number of times is to conditionize it for surface oxidation, and so render the action between the liquid and the plate after each determination unequal over the whole surface, but the making of the surface chemically clean after each determination is to bring the plate into contact with the liquid under conditions more nearly equal in each experiment.

No.	hours in solution	Weight	Date	Time	
1		28.405	Feb. 7	1.50 P.M.	
2		29.228	" "	1.55 "	
3		27.848	" "	2. "	
10		10.278	" "	2.05 "	
11		5.540	" "	2.10 "	
12		3.188	" "	2.15 "	
13		7.620	" "	2.20 "	
14		4.067	" "	2.25 "	
15		2.261	" "	2.30 "	
d	62.05	18.335	" "	2.35 "	
e	62.10	4.685	" "	2.40 "	
f	62.15	5.685	" "	2.45 "	
a	60.	5.169	" "	3.30 "	
b	60.05	5.338	" "	3.35 "	
c	60.10	5.071	" "	3.40 "	
g	71.30	14.121	" "	7.45 "	
h	71.35	14.365	" "	7.50 "	
7	~~[illegible]~~	14.422	" "	8.30 "	
8	~~60.05~~	7.217	" "	8.35 "	
9	60.10	3.768	" "	8.40 "	
1	128.10	28.370	" 12	7 "	— oxidized
2	"	29.185	" "	7.05 "	— slightly ox.
3	"	27.802	" "	7.10 "	— clean
7	118.45	14.377	" "	7.15 "	— ox.
8	118.55	7.187	" "	7.25 "	—
9	"	3.750	" "	7.30 "	— slightly ox.
10	125.30	10.237	" "	7.40 "	— clean
11	"	5.507	" "	7.45 "	— "
12	"	3.163	" "	7.50 "	— "
13	126.40	7.604	" "	9. "	— ox.

We have two plates the weight of each = 10, they are placed in a solution of the double sulphate, one plate is made the positive, the other ~~the~~ negative pole of a battery, a current passes through them, and copper is deposited on one, while an equivalent quantity is taken from the other, what one gains the other loses; represent this quantity by 2. Now the solution acts on the copper plates independently of the current which passes through them, and, the surfaces being equal each loses an equal weight, call this weight .5 The weight of the plates will now be to each other as follows:-

$A = 10+2-.5$

$B = 10-2-.5$

Difference between the two = 4

The current will now be stopped and there is no action except

No.	Leaving solution	Weight.	Date.	Time.	
15	12.6.40	2.246	Feb. 12	9.10 P.M.	clean
14	"	4.049	" "	9.05 "	"
a	12.5.45	5.145	" "	9.15 "	"
b	"	5.309	" "	9.20 "	"
c	"	5.042	" "	9.25 "	"
d	12.6.55	18.288	" "	9.30 "	slightly ox.
e	"	4.658	" "	9.35 "	clean
f	"	5.670	" "	9.40 "	~~ox.~~ ox.
g	12.2	14.082	" "	9.45 "	clean
h	"	14.327	" "	9.50 "	"
1	11.35	28.333	" 17	10.35 A.M.	~~ox~~
2	" "	29.144	" "	10.40 "	slightly ox.
3	" "	27.766	" "	10.45 "	clean
7	" "	14.361	" "	10.50 "	~~ox~~
8	" .45	7.142	" "	10.55 "	slightly ox.
9	" "	3.724	" "	11.	" "
10	" .35	10.197	" "	11.15 "	clean
11	" "	5.476	" "	11.20 "	slightly ox.
12	" "	3.143	" "	11.25 "	" "
13	11.0.45	7.590	" "	11.45 "	ox.
14	" "	4.034	" "	11.50 "	slightly ox.
15	" "	2.235	" "	11.55 "	" "
a	12.45	5.128	" "	12. M.	" "
b	" "	5.288	" "	12.05 P.M.	clean
c	" "	5.018	" "	12.10 "	slightly ox.
d	" "	18.270	" "	12.15 "	ox.
e	" "	4.655	" "	12.20 "	clean
f	" "	5.658	" "	12.25 "	ox.
h	" "	14.299	" "	12.30 "	partly ox.

on the plates except that if the solution, the surfaces being equal the loss from each will be equal - In order to determine the weight of copper deposited on A by means of the current it will only be necessary to make the following equation:

a = new weight of A
b = " " B
q = the original weight of each plate
x = change of copper by current
y = loss " " " action of solution

Then;

$$a = q + x - y$$
$$b = q - x - y$$
$$a + b = 2q - 2y$$

Or, as equal surfaces in equal times lose equal weights, one half the difference between the new weights will be the weight of "exchange" copper

No.	hours in solution	Weight	Date		Time
i	00	2.706	Feb.	19	9.15 A.M.
j	00	2.513	"	"	[illegible]
k	00	1.327	"	"	9.35 "
1	171.55	28.295	"	24	2.30 "
2	"	29.137	"	"	2.35 "
3	"	27.718	"	"	2.40 "
7	172.	14.320	"	"	2.50 "
8	"	7.111	"	"	2.55 "
9	"	3.692	"	"	3. "
10	171.50	10.137	"	"	3.05 "
11	"	5.444	"	"	3.10 "
12	"	3.116	"	"	3.15 "
13	171.35	7.566	"	"	3.20 "
14	"	4.014	"	"	3.25 "
15	"	2.118	"	"	3.30 "
a	171.45	5.113	"	"	3.45 "
b	"	5.256	"	"	3.50 "
c	"	4.987	"	"	3.55 "
d	"	18.233	"	"	4. "
e	"	4.610	"	"	4.05 "
f	"	5.637	"	"	4.10 "
h	"	14.277	"	"	4.15 "
i	187.30	2.6445	"	27	6.45 "
j	" "	2.4475	"	"	" "
k	187.	1.264	"	"	6.35 "

i, j and k ordinary rolled copper — to see if the action is not more [illegible] than with electrolytic [illegible]

Notes beside rows 1–h:
- 1: <u>oxidized</u>
- 2: "
- 3: slightly oxidized
- 7: <u>ox.</u>
- 8: slightly ox.
- 9, 10, 11, 12: "
- 13: <u>ox.</u>
- 14: "
- 15: clean
- a: ox.
- b: clean
- c: "
- d: <u>ox.</u>
- e: clean
- f: ox.
- h: <u>ox.</u>

~~In order to carry forward the surface~~

Feb. 1st 1880

A— Solution containing double sulphate, pieces metallic copper: object: to allow the solution to become saturated by acting on the copper; after it has become saturated to be used for further meter experiments — Pg. 270

By the following: (Page 258)
Place a copper plate in a solution of the double sulphate (newly prepared), and allow the action to go on for some time, then remove, wash and reweigh the plate; now introduce into the same solution a new plate, one which has never been used for experimental purposes, let it remain in the solution as many hours as the first plate was in, then remove, wash and reweigh; repeat this with a fresh plate, and then compare the losses

No.	hours in solution	Weight	Date		Time
1	00	3.314	Mch.	4	12.30 A.M.
2	"	3.012	"	"	12.35 "
3	"	3.290	"	"	12.40 "
4	"	1.671	"	"	1. "
5	"	1.615	"	"	1.05 "
6	"	1.614	"	"	1.10 "
7	"	.969	"	"	1.15 "
8	"	.9465	"	"	1.20 "
9	"	.942	"	"	1.25 "
10	"	1.5425	"	"	10.45 "
11	"	1.410	"	"	10.50 "
12	"	1.172	"	"	10.55 "
13	"	1.042	"	"	11. "
14	"	.963	"	"	11.05 "
15	"	1.168	"	"	11.10 "
16	"	3.1575	"	"	12.45 "
17	"	2.460	"	"	12.50 "
18	"	2.9815	"	"	12.55 "
19	"	3.264	"	5	3. A.M.
20	"	2.984	"	"	3.05 "
21	"	3.317	"	"	3.10 "
22	"	3.109	"	"	3.15 "
23	"	2.948	"	"	3.20 "
24	"	3.2655	"	"	3.25 "
19	12	3.258¼	"	"	3. P.M.
20	"	2.978¼	"	"	3.05 "
21	"	3.310¼	"	"	3.10 "
22	"	3.1035	"	"	3.15 "

In these experiments hard rolled copper, .005 in. thick was used.

Three sizes of plates were used; large, med. and small. large = 2 × 2 in. on one side. med. = 2 × 1 in. on one side, small = 2 × ½ in. on one side.

Two kinds of solutions - ordinary copper sulphate and the double sulphate of copper and ammonia.

Sp. gr. of copper sulphate, 1.21 at 75° F.

Sp. gr. of the double sulphate, 1.14 at 75° F.

2, 4, 5, 6, 7, 8, 9 and 17 cut from a different sheet of copper than the others.

Feb. 2, 1880 - 2 P.M. Bichromate

Three freshly prepared ~~[illegible]~~ cells were taken, an outside resistance of 600 Ohms used, and 3 cells, each containing ~~th~~ an equal quantity of an aqueous solution of the double sulphate copper and ammonia, placed in circuit, each cell contained two copper plates - the surfaces of the plates were all equal - the one as "receiver" the other as "replenisher" in the deposition of copper by the current - Feb. 3. 2 P.M. the plates were removed from the solution, washed and reweighed.

The following are the weights before and after the action of the current =

	Before	After
Cell No. 1	14.925	15.200
	13.860	13.583

Supposing one plate used

	One Plate		Two Plates
No. 1,	275	Mllgr in place	286
No. 2,	280	–	282
No. 3	274		285

add 5 mllgr

			Error
No. 1	280		– 6 Mllgr
No. 2	285	1% error	+ 3
No. 3	279		– 6

Page 258 suppose one plate used

	One Plate		Two plates
No. 1,	62 Mllgr	in place	68.5 Mllgr
2,	62 Mllgr	" "	65.2 Mllgr
3,	62	" " "	67.5 Mllgr

add 5 Mllgr.

67	error	– 1.5 Mllgr
67		+ 1.8
67		– .5

Cell No. 2 $\left.\begin{matrix}15.897\\14.440\end{matrix}\right\}$ Before $\left\{\begin{matrix}16.164\\14.145\end{matrix}\right.$ After

Cell No. 3 $\left.\begin{matrix}15.413\\14.458\end{matrix}\right\}$ Before $\left\{\begin{matrix}15.687\\14.181\end{matrix}\right.$ After

The amount deposited in each case was worked out by means of the following equation:

$$a = q + x - y$$
$$b = q - x - y$$
$$a + b = 2q \quad - 2y$$

The following are the amounts deposited in cells 1, 2 and 3 respectively:

No. 1	.286	per hour	.0119
No. 2	.2825		.0117
No. 3	.2855		.0118
		per minute	.000198
			.000195
			.000196

Per Weber estimated
Gr .0196 per minute
19.6 Mllgr

No.	hours in solution	Weight	Date	Time
23	12	2.9425	Mch. 5	3.20 P.M.
24	"	3.260	" "	3.25 "
19	00	3.252	" "	5. "
20	"	3.2545	" "	5.05 "
21	"	3.4045	" "	5.10 "
22	"	3.3075	" "	5.15 "
23	"	3.307	" "	5.20 "
24	"	3.021	" "	5.25 "
19	24	3.242¼	" 6	5. "
20	"	3.246	" "	5.05 "
21	"	3.395	" "	5.10 "
22	"	3.297¾	" "	5.15 "
23	"	3.2975	" "	5.20 "
24	"	3.0115	" "	5.25 "
19	00	2.933	" "	12. P.M.
20	"	3.209¾	" "	" "
21	"	3.218¾	" "	" "
22	"	3.354¾	" "	" "
23	"	3.1795	" "	" "
24	"	3.087¼	" "	" "
19	48	2.9165	" 8	" "
20	"	3.1965	" "	" "
21	"	3.204	" "	" "
22	"	3.3355	" "	" "
23	"	3.161	" "	" "
24	"	3.0685	" "	" "
19	00	3.219	" 9	1. A.M.
20	"	3.075	" "	1.05 "

1, 2, 3, 16, 17, 18, 19, 20, 21, 22, 23, 24 – large sizes in 200 c.c. of the solutions

1, 2, 3, 19, 20, 21 in copper sulphate solution

16, 17, 18, 22, 23, 24 in double sulphate solution

4, 5, 6, 10, 11, 12 med. sizes in copper sulphate solution.

4, 5 and 6 in 200 c.c.

10, 11 and 12 in 100 c.c.

7, 8, 9, 13, 14, 15 small sizes in copper sulphate solution

7, 8 and 9 in 200 c.c.

13, 14, 15 in 50 c.c.

See page 253 for the plan being used with Nos. 19, 20, 21, 22, 23 and 2[4]

Feb. 3 – 5. P.M.

The same arrangement used but in place of 600 Ohms, 2200 were used as outside resistance. The current was passed through the plates for 21 hours – they were taken out at 2 P.M. Feb. 4.

Weights of the plates before and after current had passed through them.

	Before	After
Cell, 1	15.200 13.563	15.262 13.488
Cell, 2	16.1675 14.145	16.099 14.207
Cell, 3	15.687 15.406	15.749 15.333

The amounts deposited in cells 1, 2, 3 respectively

	per hour	per minute
.0685	.0032	.00005
.0652	.0031	.00005
.0675	.0032	.0000[illegible]

No.	hours in solution	Weight	Difference	Date	Time	
21	50	3.1165		Mch 9	1.10 A.M.	
22	"	3.259		"	1.15 "	
23	"	3.279¼		"	1.20 "	
24	"	3.410¾		"	1.25 "	
19	48	3.206	.013	11	1. A.M.	19, 20 and 21 signs of oxidation having commenced –
20	"	3.063	.012	"	1.05 "	
21	"	3.1035	.013	"	1.10 "	
22	"	3.2395	.0195	"	1.15 "	
23	"	3.2605	.018¼	"	1.20 "	
24	"	3.392	.018¾	"	1.25 "	
19	50	2.999		"	6.30 "	
20	"	3.0535		"	6.35 "	
21	"	3.058		"	6.40 "	
22	"	3.0105		"	6.45 "	
23	"	2.858¼		"	6.50 "	
24	"	3.165		"	6.55 "	
19	[illegible]	2.992	.007	13	6.30 P.M.	19, 20 and 21 thoroughly oxidized –
20	"	3.045	.0085	"	6.35 "	
21	"	3.052	.006	"	6.40 "	
22	"	2.983	.0275	"	6.45 "	
23	"	2.833¼	.025	"	6.50 "	
24	"	3.139¼	.026¾	"	6.55 "	
1	252	3.257¾	.056¼	14	12.30 "	Very slightly oxidized
2	"	2.947¾	.064½	"	12.35 "	
3	"	3.2325	.0575	"	12.40 "	
[illegible]	"	3.0675	.060	"	12.45 "	clean
[illegible]	"	2.878	.082	"	12.50 "	
[illegible]	"	2.900	.0815	"	12.55 "	
4	"	1.624¾	.046¾	"	1. "	

Per Weber
Gr: .0195 per minute =
19.5 Mllgr

Feb. 5. 2.30. A.M.

Same arrangement used, in place of 2,200 Ohms, 37800 were used. The current was allowed to pass 19.5 hours. They were taken out 10. P.M. Feb. 5

Weights of the plates before and after current had passed through them:

	Before	After
Cell. 1	15.262 13.488	15.250 13.487
Cell. 2	16.007 14.206	15.996 14.201
Cell. 3	15.749 15.333	15.738 15.330

No.	Per cent of solution	Weight	Difference	Date	Time	
5	25.2	1.571	.044	Mar. 14	1.05 P.M.	K4 clean
6	"	1.5575	.0565	14	1.10 "	
7	"	.933¾	.035¼	"	1.15 "	clean
8	"	.9035	.043	"	1.20 "	
9	"	.9055	.0365	"	1.25 "	
10	"	1.1205	.022	"	10.45 "	Badly oxidized
11	"	1.3765	.0335	"	10.50 "	
12	"	1.1345	.0325	"	10.55 "	
13	"	1.0295	.0125	"	11. "	
14	"	.954	.009	"	11.05 "	
15	"	1.1585	.0095	"	11.10 "	
1	00	15.7485		Mar. 24	4.50 P.M.	Solution of
2	"	14.1616		"	4.55 "	$Cu(NH_4)_2(SO_4)_2$
3	"	19.146		"	5. "	Sp. gr. 1.15 - 75°
4	"	14.5486		"	5.05 "	
5	"	8.1637		"	5.10 "	Copper, electro-
6	"	8.0103		"	5.15 "	lyte - 1/32 thick
7	"	8.445		"	5.20 "	
8	"	4.2523		"	5.25 "	1, 2, 3 and 4 —
9	"	4.2195		"	5.30 "	2 × 2 in. in
10	"	4.1178		"	5.35 "	250 c.c. solution
11	"	4.1523		"	5.40 "	~~5~~, 6 and 7 —
12	"	8.5495		"	5.45 "	2 × 1 in. in 250
13	"	8.5795		"	5.50 "	c.c. solution

The amounts deposited in cells 1, 2, 3 respectively

.0055 | per ~~hour~~ .000282
.003 | .000154
.006 | .000307

~~Per Weber per hour .11 gr~~ ~~110. Milligr~~

Per Weber per hour 1.87 gram

Feb. 8, 5.50 P.M.
5 voltameters used; outside resistance = 12,600 Ohms -
In voltameters 1, 2 and 3 the surface of each plate greater than in 4 and 5 —
~~Current commenced with 1 P.M.~~
~~Feb. 9 — was stopped 8 A.M. Feb. 9~~
Current commenced & was stopped: work:

Feb. 9 – 1 A.M.	Feb. 9 – 8 A.M.
" " – 6 P.M.	" 10-12 P.M.
" 11 – 4 P.M.	" 11-10 P.M.

~~No. of hours plates were in solution~~
~~Feb~~

No.	hours in solution	Weights	Difference	Date	Time	
14	00	9.6977		Mar. 24	5.55 P.M.	
15	"	9.8755		"	6 "	8, 9, 10 and 11 –
16	"	4.9765		"	6.05 "	2 x ½ in. in 25
17	"	4.581		"	6.10 "	c.c. solution
18	"	4.516		"	6.15 "	12, 13, 14 and 15
19	"	5.1772		"	6.20 "	2 x 1 in. in 125
20	"	13.6505		26	6. "	c.c. solution
21	"	13.4125		"	6.05 "	16, 17, 18 and 19
22	"	17.5605		"	6.10 "	2 x ½ in. in 63
23	"	17.447		"	6.15 "	c.c. solution
20	18	13.639	.0115	27	12. "	20, 21, 22 and 23
21	"	13.4025	.010	"	12.05 "	2 x 2 in. in 25
22	"	17.549	.0115	"	12.10 "	c.c. solution
23	"	17.436	.011	"	12.15 "	
20	00	13.639		"	3. "	One side of the
21	"	13.4025		"	3.05 "	plate are rough
22	"	17.549		"	3.10 "	the other smooth
23	"	17.436		"	3.15 "	
20	18.5	13.6335	.0055	28	9.30 A.M.	
21	"	13.3972	.0053	"	"	
22	"	17.544	.005	"	"	
23	"	17.430	.006	"	"	
20	00	13.4867		"	4.30 P.M.	
21	"	13.2371		"	4.35 "	

Number of hours plates were in solution = 72

Number of hours current passed through them = 43

Weights of plates before and after being placed in solution and current passed through them –

~~Cell~~ 1	15.335 15.193	Before	15.335 15.147	After
Cell. 2	15.462 14.847	Before	15.458 14.799	After
" 3	15.252 14.969	Before	15.243 14.925	After
" 4	11.421 11.365	Before	11.410 11.313	After
" 5	11.969 11.413	Before	11.918 11.408	After

No.	Hours in solution	Weight	Difference	Date	Time	
22	00	17.4191		Mar 28	4.40 P.M.	20, 21, 22 and 23 were washed in nitric acid this time before being placed in solution
23	"	17.3021		"	4.45 "	
20	18	13.4787	.008	29	10.30 A.M.	
21	"	13.2309	.0062	"	10.35 "	
22	"	17.4123	.0068	"	10.40 "	
23	"	17.2952	.0069	"	10.45 "	
20	00	13.4787		"	3.30 P.M.	
21	"	13.2309		"	3.35	
22	"	17.4123		"	3.40 "	
23	"	17.2952		"	3.45	
20	18	13.4735	.0052	30	9.30 A.M.	The temperature of the room higher during this last 18 hours than during the previous 18.
21	"	13.2227	.0082	"	9.35	
22	"	17.4049	.0074	"	9.40 "	
23	"	17.2879	.0073	"	9.45 "	
20	00	13.2165		31	8 P.M.	New plates
21	"	13.3635		"	8.05 "	
22	"	14.231		"	8.10 "	
23	"	14.0785		"	8.15 "	
20	18	13.2115	.005	April 1	2 "	
21	"	13.3551	.0084	"	2.05 "	About 1/2 the surface of No 20 seemed greasy. Water would not adhere to it. 21, also. 23 also.
22	"	14.2218	.0092	"	2.10 "	
23	"	14.[illegible]705	.008	"	2.15 "	
20	00	13.2115		"	3.30 "	
21	"	13.3551		"	3.35 "	

Amount deposited in 1, 2, 3, 4 and 5 respectively:

		per hour
No. 1	.023	.000535
2	.022	.000511
3	.018	.000419
4	.020	.000465
5	.023	.000535

per Weber per hour 1.07 gr.

March 9. 1.30 P.M.
1 freshly prepared bichromate cell through 1000 Ohms resistance
4 voltameters each containing 275 c.c. solution ordinary sulphate copper of Sp. Gr. 1.21 at 75° F.
Size of plates in voltameters 2 x 2 in. hard rolled copper .005 in thick.
Number of hours current passed through voltameters 36 hours...

No.	Hours in solution	Weight	Difference	Date	Time	
22	00	14.2218		April 1	3.40 P.M.	
23	"	14.0705		"	3.45 "	
20	18	13.2065	.005	2	9.30 A.M.	
21	"	13.3494	.0057	"	9.35 "	
22	"	14.216	.0058	"	9.40 "	
23	"	14.0644	.0061	"	9.45 "	
20	00	12.797		"	3.30 P.M.	Washed this time in HNO_3
21	"	13.1891		"	3.35 "	
22	"	14.0418		"	3.40 "	
23	"	13.8829		"	3.45 "	
20	18	12.7915	.0055	3	9.30 A.M.	Average Temp. 62° F.
21	"	13.164	.0051	"	9.35 "	
22	"	14.0372	.0046	"	9.40 "	
23	"	13.8776	.0053	"	9.45 "	
20	00	12.7915		4	3. P.M.	All slightly oxidized over the whole surface
21	"	13.164		"	3.05 "	
22	"	14.0372		"	3.10 "	
23	"	13.8776		"	3.15 "	
20	18	12.7861	.0054	5	9. A.M.	Average Temp. 68° F.
21	"	13.1583	.0057	"	9.05 "	
22	"	14.0319	.0053	"	9.10 "	
23	"	13.8718	.0058	"	9.15 "	

Weight of plates before and after placed in solution.

	Before	After
No. 1	3.25275	3.320
No. 2	3.007	3.07475
No. 3	3.2165	3.28475
No. 4	2.95075	3.01575

Loss from plates same as used in these experiments for 36 hours in 200 c.c. same solution as used in these experiments .0155 grs. ~~[illegible]~~

Say there was a loss of 16 Milligrs. from these plates for the 36 hours in solution

Then the amount

No.	hours of solution	Weight	Difference	Date April	Time
1a	00	13.877		5	3. P.M.
2a	"	13.001		"	3.05 "
3a	"	13.656		"	3.10 "
1a	18	13.8735	.0035	6	9. A.M.
2a	"	12.9968	.0042	"	9.05 "
3a	"	13.6525	.0035	"	9.10 "
20	00	15.2968		7	3. P.M.
21	"	15.9916		"	3.05 "
22	"	15.2431		"	3.10 "
23	"	16.1722		"	3.15 "
20	18	15.2891	.0077	8	9. A.M.
21	"	15.9835	.0081	"	9.05 "
22	"	15.235	.0081	"	9.10 "
23	"	16.1642	.008	"	9.15 "
24	00	6.7713		8	4.30 P.M.
25	"	6.7929		"	4.35 "
26	"	6.7419		"	4.40 "
27	"	6.7543		"	4.45 "
20	"	15.2891		"	3.30 "
21	"	15.9835		"	3.35 "
22	"	15.235		"	3.40 "
23	"	16.1642		"	3.45 "
20	18	15.282	.0071	9	9.30 A.M.
21	"	15.9765	.007	"	9.35 "

1a, 2a and 3a – plates used in former experiments, size 2 x 2 in., scoured in HNO_3, placed in 250 c.c. solution of double sulphate which had been acting on copper for over two months. see pp. 253

The plates after remaining in the solution for 18 hours were found to be oxidized –

New plates

Average Temp. 68.5 F.

⟹ Hard rolled copper 1/64 in thick in place of electrolytic copper

Fresh solution 250 c.c. $Cu(NH_4)_2(SO_4)_2$

of copper deposited on each plate will be

No. 1 – 3.336
3.25275
.08325

No. 2 – 3.09075
3.007
.08375

No. 3 – 3.30075
3.2165
.08425

No. 4 – 3.03175
2.95075
.08100

Deposit per hour 2.31 Millgrs.

Per Weber per hour 1.155 grms.

No.	hours in solution	Weight	Difference	Date	Time
22	18	15.228	.007	April 9	9.40 A.M.
23	"	16.157	.0072	"	9.45 "
24	"	6.7635	.0078	"	10.30 "
25	"	6.7852	.0077	"	10.35 "
26	"	6.734	.0079	"	10.40 "
27	"	6.7462	.0081	"	10.45 "
20	00	15.1402		10	4. P.M.
21	00	15.8572		"	4.05 "
22	"	15.087		"	4.10 "
23	"	16.0437		"	4.15 "
24	"	6.5452		"	4.20 "
25	"	6.6252		"	4.25 "
26	"	6.639		"	4.30 "
27	"	6.608		"	4.35 "
20	18	15.1342	.006	11	10. A.M.
21	"	15.8514	.0058	"	10.05 "
22	"	15.0815	.0055	"	10.10 "
23	"	16.0372	.0065	"	10.15 "
24	"	6.5393	.0059	"	10.20 "
25	"	6.6197	.0055	"	10.25 "
26	"	6.6335	.0055	"	10.30 "
27	"	6.6026	.0054	"	10.35 "
24	00	6.5393		11	4.15 P.M.
25	"	6.6197		"	4.20 "

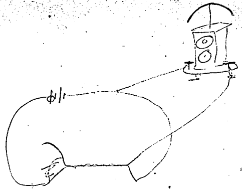
solution 20–27 Average temp. 67° F.

Plates washed in HNO3

Average temp. 66° F.

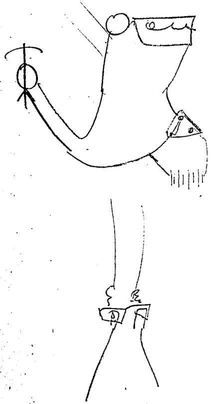
No.	hours in solution	Weight	Difference	Date	Time
26	00	6.6335		April 11	4.25 P.M.
27	"	6.6026		"	4.30 "
24	18	6.5323	.007	12	10.15 A.M.
25	"	6.613	.0067	"	10.20 "
26	"	6.6278	.0057	"	10.25 "
27	"	6.5969	.0057	"	10.30 "

Average temp. 70° F.

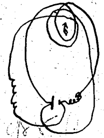


100

70,0.00



$\frac{1}{12} + \frac{1}{24} = \frac{2}{24}\ \frac{1}{24} = \frac{3}{24}\ \frac{1}{8}$



$\frac{1}{12}\frac{1}{24}$

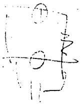
88

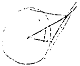
12^0

$1\frac{1}{2}$

Lincoln

57.454.75
57.450.50
4.25





15.62) 15.62
320
300
200
00

80
32
48